

ATTACHMENT F

Supporting Information for Uncertainty Analysis

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ATTACHMENT F1

Exposure Point Concentration Summary

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Attachment F1

Table 1
Exposure Point Concentration
Residential Receptor Exposed to Surface Soil (0-1 feet)

Analyte	Detection Range (mg/kg)	Frequency of Detection	Maximum Concentration (mg/kg)	Average Concentration (mg/kg)	95% UCL (mg/kg)	Distribution	Statistic used for 95% UCL	Rationale	Selected EPC (mg/kg)
Inorganics									
Arsenic	1.4 - 8.5	11 / 12	8.5	2.8	3.67	gamma	Standard Bootstrap		3.67
Lead	22 - 440	11 / 12	440	83.4	-	-	-	Per EPA Guidance	83.40
SVOCs									
Benzo(a)pyrene	0.085 - 0.39	6 / 12	0.39	0.1	0.18	gamma	Standard Bootstrap		0.18

All units are milligrams per kilogram (mg/kg).

EPC- Exposure Point Concentration

mg/kg – milligrams per kilogram

Sd- Standard Deviation

SVOC- Semi-volatile organic compound

UCL- Upper Confidence Limit

VOC- Volatile organic compound

Attachment F1

Table 2
Exposure Point Concentration
Residential Receptor Exposed to Surface and Subsurface Soil (0-3 feet)

Analyte	Detection Range (mg/kg)	Frequency of Detection	Maximum Concentration (mg/kg)	Average Concentration (mg/kg)	95% UCL (mg/kg)	Distribution	Statistic used for 95% UCL	Rationale	Selected EPC (mg/kg)
Inorganics									
Arsenic	0.87 - 13	29 / 40	13	2.97	3.74	gamma	Standard Bootstrap		3.7
Lead	9.6 - 4000	26 / 40	4000	176.19	-	-	-	Per EPA Guidance	176.2
SVOCs									
1-Methylnaphthalene	0.051 - 230	8 / 40	230	7.21	16.61	non-parametric	Standard Bootstrap		16.6
Benzo(a)anthracene	0.044 - 190	18 / 40	190	5.77	13.58	non-parametric	Standard Bootstrap		13.6
Benzo(a)pyrene	0.060 - 220	18 / 40	220	6.97	16.13	non-parametric	Standard Bootstrap		16.1
Benzo(b)fluoranthene	0.070 - 180	21 / 40	180	6.12	13.47	non-parametric	Standard Bootstrap		13.5
Benzo(k)fluoranthene	0.069 - 56	13 / 40	56	1.98	4.23	non-parametric	Standard Bootstrap		4.2
Dibenz(a,h)anthracene	0.12 - 3.8	3 / 40	3.8	0.39	0.76	non-parametric	Standard Bootstrap		0.8
Fluoranthene	0.047 - 390	21 / 40	390	11.18	26.47	non-parametric	Standard Bootstrap		26.5
Indeno(1,2,3-cd)pyrene	0.037 - 45	12 / 40	45	1.54	3.39	non-parametric	Standard Bootstrap		3.4
Naphthalene	0.051 - 91	7 / 40	91	2.82	6.46	non-parametric	Standard Bootstrap		6.5
Pyrene	0.046 - 670	24 / 40	670	19.10	46.98	non-parametric	Standard Bootstrap		47.0
VOCs									
1,2,4-Trimethylbenzene	0.02 - 15	13 / 40	15	0.61	1.31	non-parametric	Standard Bootstrap		1.3
1,3,5-Trimethylbenzene	0.041 - 5.4	4 / 40	5.4	0.23	0.48	non-parametric	Standard Bootstrap		0.5
Benzene	0.018 - 25	7 / 40	25	0.89	1.93	non-parametric	Standard Bootstrap		1.9

All units are milligrams per kilogram (mg/kg).

EPC – Exposure Point Concentration

mg/kg – milligrams per kilogram

Sd – Standard Deviation

SVOC – Semi-volatile organic compound

UCL – Upper Confidence Limit

VOC – Volatile organic compound

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Table 3
Exposure Point Concentration
Construction Worker Receptor Exposed to Surface and Subsurface Soil (0-4 feet)

Analyte	Detection Range (mg/kg)	Frequency of Detection	Maximum Concentration (mg/kg)	Average Concentration (mg/kg)	95% UCL (mg/kg)	Distribution	Statistic used for 95% UCL	Rationale	Selected EPC (mg/kg)
Inorganics									
Arsenic	0.83 - 27	87 / 127	27	3.74	4.40	non-parametric	Standard Bootstrap		4.40
Lead	3.32 - 4000	104 / 131	4000	100.18	-	-	-	Per EPA Guidance	100.18
Vanadium	8.8 - 110	90 / 90	110	28.69	31.24	gamma	Standard Bootstrap		31.24
SVOCs									
2-Methylnaphthalene	0.066 - 30000	39 / 119	30000	1,141.94	1,875.53	non-parametric	Standard Bootstrap		1,875.53
Acenaphthene	0.074 - 7400	32 / 121	7400	205.28	337.87	non-parametric	Standard Bootstrap		337.87
Acenaphthylene	0.045 - 9700	49 / 122	9700	324.90	549.86	non-parametric	Standard Bootstrap		549.86
Benzo(a)anthracene	0.0173 - 2400	72 / 132	2400	130.01	200.02	non-parametric	Standard Bootstrap		200.02
Benzo(a)pyrene	0.0219 - 2600	75 / 145	2600	95.89	147.36	non-parametric	Standard Bootstrap		147.36
Benzo(b)fluoranthene	0.0149 - 1200	79 / 128	1200	61.33	91.47	non-parametric	Standard Bootstrap		91.47
Benzo(k)fluoranthene	0.00669 - 1500	55 / 129	1500	72.78	112.03	non-parametric	Standard Bootstrap		112.03
Chrysene	0.0118 - 2300	67 / 127	2300	115.48	175.37	non-parametric	Standard Bootstrap		175.37
Dibeno(a,h)anthracene	0.12 - 290	21 / 116	290	14.15	21.43	non-parametric	Standard Bootstrap		21.43
Dibenzofuran	0.042 - 1400	22 / 108	1400	69.47	111.12	non-parametric	Standard Bootstrap		111.12
Fluoranthene	0.047 - 5400	77 / 132	5400	207.20	317.80	non-parametric	Standard Bootstrap		317.80
Fluorene	0.00195 - 4600	37 / 125	4600	198.10	306.26	non-parametric	Standard Bootstrap		306.26
Indeno(1,2,3-cd)pyrene	0.0113 - 1200	58 / 132	1200	52.58	81.40	non-parametric	Standard Bootstrap		81.40
Naphthalene	0.031 - 37000	64 / 158	37000	766.19	1,324.29	non-parametric	Standard Bootstrap		1,324.29
Pyrene	0.046 - 8400	83 / 145	8400	284.58	442.29	non-parametric	Standard Bootstrap		442.29
VOCs									
1,2,4-Trimethylbenzene	0.019 - 54	25 / 94	54	1.06	2.04	non-parametric	Standard Bootstrap		2.04
1,3,5-Trimethylbenzene	0.03 - 21	21 / 108	21	0.50	0.88	non-parametric	Standard Bootstrap		0.88
Benzene	0.018 - 52	29 / 127	52	0.99	1.78	non-parametric	Standard Bootstrap		1.78

All units are milligrams per kilogram (mg/kg).

EPC- Exposure Point Concentration

mg/kg – milligrams per kilogram

SVOC- Semi-volatile organic compound

UCL- Upper Confidence Limit

VOC- Volatile organic compound

ATTACHMENT F2

ProUCL Output Tables

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Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
1,2,4-Trimethylbenzene

Raw Statistics			
Number of Valid Samples	94	Lilliefors Test Statistic	0.47356435
Number of Unique Samples	27	Lilliefors 5% Critical Value	0.09138392
Minimum	7.5	Data not normal at 5% significance level	
Maximum	54000		
Mean	1057.04255	95% UCL (Assuming Normal Distribution)	
Median	7.5	Student's-t UCL	2075.27269
Standard Deviation	5942.02949		
Variance	35307714.5		
Coefficient of Variation	5.62137208	Gamma Distribution Test	
Skewness	8.00283819	A-D Test Statistic	26.7252893
Gamma Statistics			
k hat	0.18339203	A-D 5% Critical Value	0.92876172
k star (bias corrected)	0.18463129	K-S Test Statistic	0.41920667
Theta hat	5763.84144	K-S 5% Critical Value	0.10289104
Theta star	5725.15402	Data do not follow gamma distribution	
nu hat	34.4777007	at 5% significance level	
nu star	34.7106819	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	22.230945	Approximate Gamma UCL	1650.43222
Adjusted Level of Significance	0.04744681	Adjusted Gamma UCL	1662.05931
Adjusted Chi Square Value	22.0754263		
Log-transformed Statistics			
Minimum of log data	2.01490302	Lognormal Distribution Test	
Maximum of log data	10.8967393	Lilliefors Test Statistic	0.36882391
Mean of log data	2.89626482	Lilliefors 5% Critical Value	0.09138392
Standard Deviation of log data	1.91492888	Data not lognormal at 5% significance level	
Variance of log data	3.66695261	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	214.395105
		95% Chebyshev (MVUE) UCL	249.729044
		97.5% Chebyshev (MVUE) UCL	311.284433
		99% Chebyshev (MVUE) UCL	432.198077
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 97.5% Chebyshev (Mean, Sd) UCL		CLT UCL	2065.12983
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	2605.67426
		Mod-t UCL (Adjusted for skewness)	2159.5867
		Jackknife UCL	2075.27269
		Standard Bootstrap UCL	2041.35143
		Bootstrap-t UCL	4904.74242
		Hall's Bootstrap UCL	5032.36566
		Percentile Bootstrap UCL	2191.99468
		BCA Bootstrap UCL	2843.90957
		95% Chebyshev (Mean, Sd) UCL	3728.49641
		97.5% Chebyshev (Mean, Sd) UCL	4884.43662
		99% Chebyshev (Mean, Sd) UCL	7155.05734

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
1,3,5-Trimethylbenzene

Raw Statistics			
Number of Valid Samples	108	Lilliefors Test Statistic	0.4457922
Number of Unique Samples	26	Lilliefors 5% Critical Value	0.08525539
Minimum	8	Data not normal at 5% significance level	
Maximum	21000		
Mean	502.736111	95% UCL (Assuming Normal Distribution)	
Median	8	Student's-t UCL	891.764051
Standard Deviation	2436.62655		
Variance	5937148.96		
Coefficient of Variation	4.84673072	Gamma Distribution Test	
Skewness	6.91905779	A-D Test Statistic	28.0127715
Gamma Statistics			
k hat	0.22165551	A-D 5% Critical Value	0.90277809
k star (bias corrected)	0.22167125	K-S Test Statistic	0.4140183
Theta hat	2268.0966	K-S 5% Critical Value	0.0963714
Theta star	2267.93553	Data do not follow gamma distribution	
nu hat	47.8775905	at 5% significance level	
nu star	47.8809907	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	32.9964793	Approximate Gamma UCL	729.517317
Adjusted Level of Significance	0.04777778	Adjusted Gamma UCL	733.223954
Adjusted Chi Square Value	32.8296736		
Log-transformed Statistics			
Minimum of log data	2.07944154	Lognormal Distribution Test	
Maximum of log data	9.95227772	Lilliefors Test Statistic	0.40712397
Mean of log data	2.95325565	Lilliefors 5% Critical Value	0.08525539
Standard Deviation of log data	1.81496228	Data not lognormal at 5% significance level	
Variance of log data	3.29408806	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	170.205099
		95% Chebyshev (MVUE) UCL	206.168468
		97.5% Chebyshev (MVUE) UCL	253.95539
		99% Chebyshev (MVUE) UCL	347.823545
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 97.5% Chebyshev (Mean, Sd) UCL		CLT UCL	888.395894
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	1055.19457
		Mod-t UCL (Adjusted for skewness)	917.781273
		Jackknife UCL	891.764051
		Standard Bootstrap UCL	884.603038
		Bootstrap-t UCL	1717.63566
		Hall's Bootstrap UCL	2308.15391
		Percentile Bootstrap UCL	945.138889
		BCA Bootstrap UCL	1129.96759
		95% Chebyshev (Mean, Sd) UCL	1524.74317
		97.5% Chebyshev (Mean, Sd) UCL	1966.96644
		99% Chebyshev (Mean, Sd) UCL	2835.62843

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Dibenzofuran

Raw Statistics			
Number of Valid Samples	108	Lilliefors Test Statistic	0.4876173
Number of Unique Samples	33	Lilliefors 5% Critical Value	0.08525539
Minimum	16	Data not normal at 5% significance level	
Maximum	1400000		
Mean	69471.4676	95% UCL (Assuming Normal Distribution)	
Median	80	Student's-t UCL	111734.244
Standard Deviation	264707.474		
Variance	7.01E+10		
Coefficient of Variation	3.81030491	Gamma Distribution Test	
Skewness	4.07464934	A-D Test Statistic	22.5922559
Gamma Statistics			
k hat	0.12964901	A-D 5% Critical Value	0.99241055
k star (bias corrected)	0.13222049	K-S Test Statistic	0.37583454
Theta hat	535842.628	K-S 5% Critical Value	0.09964028
Theta star	525421.342	Data do not follow gamma distribution	
nu hat	28.0041867	at 5% significance level	
nu star	28.559626		
Approx.Chi Square Value (.05)	17.3624012	95% UCLs (Assuming Gamma Distribution)	
Adjusted Level of Significance	0.04777778	Approximate Gamma UCL	114274.466
Adjusted Chi Square Value	17.2442629	Adjusted Gamma UCL	115057.346
Log-transformed Statistics			
Minimum of log data	2.77258872	Lognormal Distribution Test	
Maximum of log data	14.1519828	Lilliefors Test Statistic	0.23564258
Mean of log data	5.09640529	Lilliefors 5% Critical Value	0.08525539
Standard Deviation of log data	3.08253181	Data not lognormal at 5% significance level	
Variance of log data	9.50200238		
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	111368.338
All units are in micrograms/kilogram ($\mu\text{g/kg}$)		Adj-CLT UCL (Adjusted for skewness)	122039.534
		Mod-t UCL (Adjusted for skewness)	113398.735
		Jackknife UCL	111734.244
		Standard Bootstrap UCL	111118.865
		Bootstrap-t UCL	133541.317
		Hall's Bootstrap UCL	111148.732
		Percentile Bootstrap UCL	113869.296
		BCA Bootstrap UCL	125220.833
		95% Chebyshev (Mean, Sd) UCL	180499.112
		97.5% Chebyshev (Mean, Sd) UCL	228540.863
		99% Chebyshev (Mean, Sd) UCL	322909.579

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Dibenzo(a,h)anthracene

Raw Statistics			
Number of Valid Samples	116	Lilliefors Test Statistic	0.46273571
Number of Unique Samples	40	Lilliefors 5% Critical Value	0.08226303
Minimum	17	Data not normal at 5% significance level	
Maximum	290000		
Mean	14152.01724	95% UCL (Assuming Normal Distribution)	
Median	85	Student's-t UCL	21717.6436
Standard Deviation	49139.86648		
Variance	2414726477	Gamma Distribution Test	
Coefficient of Variation	3.47228707	A-D Test Statistic	19.0862675
Skewness	3.981484095	A-D 5% Critical Value	0.94447465
		K-S Test Statistic	0.33030487
		K-S 5% Critical Value	0.09559749
Gamma Statistics			
k hat	0.17349028	Data do not follow gamma distribution	
k star (bias corrected)	0.174750589	at 5% significance level	
Theta hat	81572.39278		
Theta star	80984.08913	95% UCLs (Assuming Gamma Distribution)	
nu hat	40.2497449	Approximate Gamma UCL	21290.1964
nu star	40.54213655	Adjusted Gamma UCL	21400.7711
Approx.Chi Square Value (.05)	26.94916502		
Adjusted Level of Significance	0.047931034	Lognormal Distribution Test	
Adjusted Chi Square Value	26.80992256	Lilliefors Test Statistic	0.1862679
		Lilliefors 5% Critical Value	0.08226303
		Data not lognormal at 5% significance level	
Log-transformed Statistics			
Minimum of log data	2.833213344	95% UCLs (Assuming Lognormal Distribution)	
Maximum of log data	12.5776362	95% H-UCL	18673.425
Mean of log data	5.222067114	95% Chebyshev (MVUE) UCL	17510.0692
Standard Deviation of log data	2.678888018	97.5% Chebyshev (MVUE) UCL	22543.266
Variance of log data	7.17644101	99% Chebyshev (MVUE) UCL	32430.0066
		95% Non-parametric UCLs	
		CLT UCL	21656.6982
		Adj-CLT UCL (Adjusted for skewness)	23458.8916
		Mod-t UCL (Adjusted for skewness)	21998.7494
		Jackknife UCL	21717.6436
		Standard Bootstrap UCL	21430.3552
		Bootstrap-t UCL	24514.2449
		Hall's Bootstrap UCL	22189.6452
		Percentile Bootstrap UCL	22093.6552
		BCA Bootstrap UCL	23514.4741
		95% Chebyshev (Mean, Sd) UCL	34039.5898
		97.5% Chebyshev (Mean, Sd) UCL	42644.9584
		99% Chebyshev (Mean, Sd) UCL	59548.5386
RECOMMENDATION			
Data are Non-parametric (0.05)			
Use 99% Chebyshev (Mean, Sd) UCL			
All units are in micrograms/kilogram ($\mu\text{g/kg}$)			

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
2-Methylnaphthalene

Raw Statistics			
Number of Valid Samples	119	Lilliefors Test Statistic	0.48615076
Number of Unique Samples	48	Lilliefors 5% Critical Value	0.08121949
Minimum	15.5	Data not normal at 5% significance level	
Maximum	30000000		
Mean	1141938.09	95% UCL (Assuming Normal Distribution)	
Median	80	Student's-t UCL	1894823.72
Standard Deviation	4953956.8		
Variance	2.45E+13		
Coefficient of Variation	4.33820084	Gamma Distribution Test	
Skewness	4.77585526	A-D Test Statistic	25.6900887
Gamma Statistics			
k hat	0.09887446	A-D 5% Critical Value	1.06600965
k star (bias corrected)	0.10198406	K-S Test Statistic	0.39076651
Theta hat	11549374.2	K-S 5% Critical Value	0.09851127
Theta star	11197221	Data do not follow gamma distribution	
nu hat	23.5321205	at 5% significance level	
nu star	24.2722071	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	14.0541221	Approximate Gamma UCL	1972187.08
Adjusted Level of Significance	0.04798319	Adjusted Gamma UCL	1985667.13
Adjusted Chi Square Value	13.9587132		
Log-transformed Statistics			
Minimum of log data	2.74084002	Lognormal Distribution Test	
Maximum of log data	17.2167079	Lilliefors Test Statistic	0.21596058
Mean of log data	5.72293678	Lilliefors 5% Critical Value	0.08121949
Standard Deviation of log data	3.79445961	Data not lognormal at 5% significance level	
Variance of log data	14.3979238	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	2839058.99
		95% Chebyshev (MVUE) UCL	1082217.53
		97.5% Chebyshev (MVUE) UCL	1435362.79
		99% Chebyshev (MVUE) UCL	2129048.25
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	1888912.96
All units are in micrograms/kilogram ($\mu\text{g/kg}$)		Adj-CLT UCL (Adjusted for skewness)	2101353.22
		Mod-t UCL (Adjusted for skewness)	1927960.11
		Jackknife UCL	1894823.72
		Standard Bootstrap UCL	1875527.18
		Bootstrap-t UCL	2355803.85
		Hall's Bootstrap UCL	1871617.67
		Percentile Bootstrap UCL	1938119.56
		BCA Bootstrap UCL	2131075.35
		95% Chebyshev (Mean, Sd) UCL	3121438.22
		97.5% Chebyshev (Mean, Sd) UCL	3977969.51
		99% Chebyshev (Mean, Sd) UCL	5660459.37

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Acenaphthene

Raw Statistics			
Number of Valid Samples	121	Lilliefors Test Statistic	0.47684906
Number of Unique Samples	47	Lilliefors 5% Critical Value	0.08054545
Minimum	16	Data not normal at 5% significance level	
Maximum	7400000		
Mean	205284.669	95% UCL (Assuming Normal Distribution)	
Median	80	Student's-t UCL	338864.068
Standard Deviation	886419.23		
Variance	7.86E+11	Gamma Distribution Test	
Coefficient of Variation	4.31800013	A-D Test Statistic	23.6839422
Skewness	5.99499991	A-D 5% Critical Value	1.013869
Gamma Statistics			
k hat	0.11859909	K-S Test Statistic	0.35788045
k star (bias corrected)	0.121116826	K-S 5% Critical Value	0.09645984
Theta hat	1730912.64	Data do not follow gamma distribution	
Theta star	1694211.55	at 5% significance level	
nu hat	28.7009806	95% UCLs (Assuming Gamma Distribution)	
nu star	29.3227194	Approximate Gamma UCL	335175.792
Approx.Chi Square Value (.05)	17.9592468	Adjusted Gamma UCL	337188.741
Adjusted Level of Significance	0.04801653	Lognormal Distribution Test	
Adjusted Chi Square Value	17.8520337	Lilliefors Test Statistic	0.22168962
Log-transformed Statistics			
Minimum of log data	2.77258872	Lilliefors 5% Critical Value	0.08054545
Maximum of log data	15.8169906	Data not lognormal at 5% significance level	
Mean of log data	5.53497763	95% UCLs (Assuming Lognormal Distribution)	
Standard Deviation of log data	3.4336752	95% H-UCL	449668.542
Variance of log data	11.7901254	95% Chebyshev (MVUE) UCL	253892.671
		97.5% Chebyshev (MVUE) UCL	334210.447
		99% Chebyshev (MVUE) UCL	491979.165
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	337832.841
All units are in micrograms/kilogram ($\mu\text{g/kg}$)		Adj-CLT UCL (Adjusted for skewness)	384759.906
		Mod-t UCL (Adjusted for skewness)	346183.742
		Jackknife UCL	338864.068
		Standard Bootstrap UCL	337871.862
		Bootstrap-t UCL	468069.817
		Hall's Bootstrap UCL	416608.445
		Percentile Bootstrap UCL	354282.083
		BCA Bootstrap UCL	394828.302
		95% Chebyshev (Mean, Sd) UCL	556540.292
		97.5% Chebyshev (Mean, Sd) UCL	708528.88
		99% Chebyshev (Mean, Sd) UCL	1007081.03

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Fluorene

Raw Statistics			
Number of Valid Samples	125	Lilliefors Test Statistic	0.47980039
Number of Unique Samples	50	Lilliefors 5% Critical Value	0.07924625
Minimum	1.95	Data not normal at 5% significance level	
Maximum	4600000		
Mean	198104.337	95% UCL (Assuming Normal Distribution)	
Median	80	Student's-t UCL	309256.016
Standard Deviation	749871.794		
Variance	5.62E+11		
Coefficient of Variation	3.78523663	Gamma Distribution Test	
Skewness	4.11977253	A-D Test Statistic	24.3112576
Gamma Statistics			
k hat	0.11840144	A-D 5% Critical Value	1.01685988
k star (bias corrected)	0.12089314	K-S Test Statistic	0.35393406
Theta hat	1673158.11	K-S 5% Critical Value	0.09535194
Theta star	1638673.06	Data do not follow gamma distribution	
nu hat	29.6003612	at 5% significance level	
nu star	30.2232859	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	18.6664118	Approximate Gamma UCL	320756.023
Adjusted Level of Significance	0.04808	Adjusted Gamma UCL	322586.645
Adjusted Chi Square Value	18.5604833		
Log-transformed Statistics			
Minimum of log data	0.66782937	Lognormal Distribution Test	
Maximum of log data	15.3415669	Lilliefors Test Statistic	0.20962278
Mean of log data	5.48668989	Lilliefors 5% Critical Value	0.07924625
Standard Deviation of log data	3.47379961	Data not lognormal at 5% significance level	
Variance of log data	12.0672837	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	494799.306
		95% Chebyshev (MVUE) UCL	277916.594
		97.5% Chebyshev (MVUE) UCL	365950.389
		99% Chebyshev (MVUE) UCL	538875.732
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	308425.611
All units are in micrograms/kilogram ($\mu\text{g/kg}$)		Adj-CLT UCL (Adjusted for skewness)	334833.316
		Mod-t UCL (Adjusted for skewness)	313375.084
		Jackknife UCL	309256.016
		Standard Bootstrap UCL	306256.768
		Bootstrap-t UCL	369518.515
		Hall's Bootstrap UCL	319264.174
		Percentile Bootstrap UCL	315075.62
		BCA Bootstrap UCL	343095.386
		95% Chebyshev (Mean, Sd) UCL	490458.184
		97.5% Chebyshev (Mean, Sd) UCL	616959.927
		99% Chebyshev (Mean, Sd) UCL	865448.105

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Benzene

Raw Statistics			
Number of Valid Samples	127	Lilliefors Test Statistic	0.44267853
Number of Unique Samples	33	Lilliefors 5% Critical Value	0.07861979
Minimum	2.5	Data not normal at 5% significance level	
Maximum	52000		
Mean	990.590551	95% UCL (Assuming Normal Distribution)	
Median	7.5	Student's-t UCL	1771.64302
Standard Deviation	5311.90064		
Variance	28216288.4		
Coefficient of Variation	5.36235747	Gamma Distribution Test	
Skewness	8.04217502	A-D Test Statistic	28.5351817
Gamma Statistics			
k hat	0.18419738	A-D 5% Critical Value	0.93323691
k star (bias corrected)	0.18509561	K-S Test Statistic	0.40947438
Theta hat	5377.87525	K-S 5% Critical Value	0.09202776
Theta star	5351.77772	Data do not follow gamma distribution	
nu hat	46.7861354	at 5% significance level	
nu star	47.0142845	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	32.276833	Approximate Gamma UCL	1442.88958
Adjusted Level of Significance	0.04811024	Adjusted Gamma UCL	1449.16851
Adjusted Chi Square Value	32.1369846	Lognormal Distribution Test	
Log-transformed Statistics			
Minimum of log data	0.91629073	Lilliefors Test Statistic	0.38083643
Maximum of log data	10.858999	Lilliefors 5% Critical Value	0.07861979
Mean of log data	2.85183539	Data not lognormal at 5% significance level	
Standard Deviation of log data	2.19427219	95% UCLs (Assuming Lognormal Distribution)	
Variance of log data	4.81483044	95% H-UCL	379.215232
		95% Chebyshev (MVUE) UCL	438.851877
		97.5% Chebyshev (MVUE) UCL	550.481332
		99% Chebyshev (MVUE) UCL	769.755781
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	1765.90047
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	2125.31874
		Mod-t UCL (Adjusted for skewness)	1827.70501
		Jackknife UCL	1771.64302
		Standard Bootstrap UCL	1781.74088
		Bootstrap-t UCL	3226.91369
		Hall's Bootstrap UCL	4318.63965
		Percentile Bootstrap UCL	1858.31496
		BCA Bootstrap UCL	2266.1063
		95% Chebyshev (Mean, Sd) UCL	3045.17919
		97.5% Chebyshev (Mean, Sd) UCL	3934.20134
		99% Chebyshev (Mean, Sd) UCL	5680.5132

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Chrysene

Raw Statistics			
Number of Valid Samples	127	Lilliefors Test Statistic	0.46915215
Number of Unique Samples	73	Lilliefors 5% Critical Value	0.07861979
Minimum	11.8	Data not normal at 5% significance level	
Maximum	2300000		
Mean	115482.006	95% UCL (Assuming Normal Distribution)	
Median	210	Student's-t UCL	176756.417
Standard Deviation	416724.349		
Variance	1.74E+11	Gamma Distribution Test	
Coefficient of Variation	3.6085652	A-D Test Statistic	18.2235834
Skewness	4.01626009	A-D 5% Critical Value	0.98745112
		K-S Test Statistic	0.29476853
		K-S 5% Critical Value	0.09379212
Gamma Statistics			
k hat	0.14222963	Data do not follow gamma distribution	
k star (bias corrected)	0.14411922	at 5% significance level	
Theta hat	811940.588		
Theta star	801294.999	95% UCLs (Assuming Gamma Distribution)	
nu hat	36.1263251	Approximate Gamma UCL	177957.23
nu star	36.6062806	Adjusted Gamma UCL	178850.983
Approx.Chi Square Value (.05)	23.7549591		
Adjusted Level of Significance	0.04811024	Lognormal Distribution Test	
Adjusted Chi Square Value	23.636251	Lilliefors Test Statistic	0.14984438
		Lilliefors 5% Critical Value	0.07861979
		Data not lognormal at 5% significance level	
Log-transformed Statistics			
Minimum of log data	2.46809953		
Maximum of log data	14.6484197	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	6.21146606	95% H-UCL	499777.294
Standard Deviation of log data	3.30826043	95% Chebyshev (MVUE) UCL	328296.26
Variance of log data	10.9445871	97.5% Chebyshev (MVUE) UCL	430417.173
		99% Chebyshev (MVUE) UCL	631013.933
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	176305.908
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	190387.358
		Mod-t UCL (Adjusted for skewness)	178952.839
		Jackknife UCL	176756.417
		Standard Bootstrap UCL	175374.202
		Bootstrap-t UCL	207459.249
		Hall's Bootstrap UCL	180609.96
		Percentile Bootstrap UCL	178544.825
		BCA Bootstrap UCL	197575.575
		95% Chebyshev (Mean, Sd) UCL	276666.707
		97.5% Chebyshev (Mean, Sd) UCL	346411.456
		99% Chebyshev (Mean, Sd) UCL	483411.509

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Arsenic

Raw Statistics			
Number of Valid Samples	127	Lilliefors Test Statistic	0.22583208
Number of Unique Samples	85	Lilliefors 5% Critical Value	0.07861979
Minimum	0.325	Data not normal at 5% significance level	
Maximum	27		
Mean	3.74129921	95% UCL (Assuming Normal Distribution)	
Median	2.165	Student's-t UCL	4.40871578
Standard Deviation	4.53906829		
Variance	20.603141		
Coefficient of Variation	1.21323317	Gamma Distribution Test	
Skewness	2.38243287	A-D Test Statistic	2.64953541
Gamma Statistics			
k hat	0.92678322	A-D 5% Critical Value	0.78677016
k star (bias corrected)	0.91014005	K-S Test Statistic	0.13549311
Theta hat	4.03686551	K-S 5% Critical Value	0.08517572
Theta star	4.1106852	Data do not follow gamma distribution	
nu hat	235.402938	at 5% significance level	
nu star	231.175572		
Approx.Chi Square Value (.05)	196.973414	95% UCLs (Assuming Gamma Distribution)	
Adjusted Level of Significance	0.04811024	Approximate Gamma UCL	4.39093259
Adjusted Chi Square Value	196.614116	Adjusted Gamma UCL	4.39895672
Log-transformed Statistics			
Minimum of log data	-1.1239301	Lognormal Distribution Test	
Maximum of log data	3.29583687	Lilliefors Test Statistic	0.15932906
Mean of log data	0.69091531	Lilliefors 5% Critical Value	0.07861979
Standard Deviation of log data	1.15929275	Data not lognormal at 5% significance level	
Variance of log data	1.34395968		
		95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	4.96942263
		95% Chebyshev (MVUE) UCL	6.06849418
		97.5% Chebyshev (MVUE) UCL	7.01823701
		99% Chebyshev (MVUE) UCL	8.8838229
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 97.5% Chebyshev (Mean, Sd) UCL		CLT UCL	4.40380872
All units are in milligrams/kilogram (mg/kg)		Adj-CLT UCL (Adjusted for skewness)	4.49479252
		Mod-t UCL (Adjusted for skewness)	4.42290741
		Jackknife UCL	4.40871578
		Standard Bootstrap UCL	4.40436271
		Bootstrap-t UCL	4.51598096
		Hall's Bootstrap UCL	4.55697929
		Percentile Bootstrap UCL	4.41472441
		BCA Bootstrap UCL	4.50527559
		95% Chebyshev (Mean, Sd) UCL	5.49696424
		97.5% Chebyshev (Mean, Sd) UCL	6.25664189
		99% Chebyshev (Mean, Sd) UCL	7.74888155

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Benzo(b)fluoranthene

Raw Statistics			
Number of Valid Samples	128	Lilliefors Test Statistic	0.44700603
Number of Unique Samples	73	Lilliefors 5% Critical Value	0.07831208
Minimum	14.9	Data not normal at 5% significance level	
Maximum	1200000		
Mean	61328.65	95% UCL (Assuming Normal Distribution)	
Median	375	Student's-t UCL	91966.9858
Standard Deviation	209200.819		
Variance	4.38E+10		
Coefficient of Variation	3.41114339	Gamma Distribution Test	
Skewness	3.99192713	A-D Test Statistic	15.1002466
Gamma Statistics			
k hat	0.16351415	A-D 5% Critical Value	0.96027302
k star (bias corrected)	0.16489012	K-S Test Statistic	0.26706973
Theta hat	375066.312	K-S 5% Critical Value	0.09261453
Theta star	371936.47	Data do not follow gamma distribution	
nu hat	41.8596229	at 5% significance level	
nu star	42.2118714	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	28.3153035	Approximate Gamma UCL	91427.4883
Adjusted Level of Significance	0.048125	Adjusted Gamma UCL	91847.1744
Adjusted Chi Square Value	28.1859197		
Log-transformed Statistics			
Minimum of log data	2.70136121	Lognormal Distribution Test	
Maximum of log data	13.9978321	Lilliefors Test Statistic	0.12931054
Mean of log data	6.38288746	Lilliefors 5% Critical Value	0.07831208
Standard Deviation of log data	3.14491271	Data not lognormal at 5% significance level	
Variance of log data	9.89047597	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	305607.044
		95% Chebyshev (MVUE) UCL	228475.887
		97.5% Chebyshev (MVUE) UCL	298147.941
		99% Chebyshev (MVUE) UCL	435005.199
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	91743.4981
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	98714.8408
		Mod-t UCL (Adjusted for skewness)	93054.3744
		Jackknife UCL	91966.9858
		Standard Bootstrap UCL	91472.7651
		Bootstrap-t UCL	105630.447
		Hall's Bootstrap UCL	95308.6733
		Percentile Bootstrap UCL	93811.6531
		BCA Bootstrap UCL	101137.446
		95% Chebyshev (Mean, Sd) UCL	141928.679
		97.5% Chebyshev (Mean, Sd) UCL	176804.375
		99% Chebyshev (Mean, Sd) UCL	245310.928

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Benzo(k)fluoranthene

Raw Statistics			
Number of Valid Samples	129	Lilliefors Test Statistic	0.46888634
Number of Unique Samples	63	Lilliefors 5% Critical Value	0.07800795
Minimum	6.69	Data not normal at 5% significance level	
Maximum	1500000		
Mean	72775.6278	95% UCL (Assuming Normal Distribution)	
Median	165	Student's-t UCL	111953.32
Standard Deviation	268566.496		
Variance	7.21E+10		
Coefficient of Variation	3.69033569	Gamma Distribution Test	
Skewness	4.03764476	A-D Test Statistic	21.2803171
Gamma Statistics			
k hat	0.143497	A-D 5% Critical Value	0.98677608
k star (bias corrected)	0.14532782	K-S Test Statistic	0.30704642
Theta hat	507157.831	K-S 5% Critical Value	0.09317662
Theta star	500768.729	Data do not follow gamma distribution	
nu hat	37.0222263	at 5% significance level	
nu star	37.4945776	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	24.4724793	Approximate Gamma UCL	111500.408
Adjusted Level of Significance	0.04813953	Adjusted Gamma UCL	112043.972
Adjusted Chi Square Value	24.353755		
Log-transformed Statistics			
Minimum of log data	1.90061387	Lognormal Distribution Test	
Maximum of log data	14.2209757	Lilliefors Test Statistic	0.17026021
Mean of log data	5.8046788	Lilliefors 5% Critical Value	0.07800795
Standard Deviation of log data	3.09896184	Data not lognormal at 5% significance level	
Variance of log data	9.6035645	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	142548.337
		95% Chebyshev (MVUE) UCL	110600.617
		97.5% Chebyshev (MVUE) UCL	144103.805
		99% Chebyshev (MVUE) UCL	209914.33
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	111669.773
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	120651.724
		Mod-t UCL (Adjusted for skewness)	113354.322
		Jackknife UCL	111953.32
		Standard Bootstrap UCL	112025.089
		Bootstrap-t UCL	130356.128
		Hall's Bootstrap UCL	115090.333
		Percentile Bootstrap UCL	113146.012
		BCA Bootstrap UCL	123071.923
		95% Chebyshev (Mean, Sd) UCL	175845.985
		97.5% Chebyshev (Mean, Sd) UCL	220444.61
		99% Chebyshev (Mean, Sd) UCL	308049.974

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Lead

Raw Statistics			
Number of Valid Samples	131	Lilliefors Test Statistic	0.39302721
Number of Unique Samples	105	Lilliefors 5% Critical Value	0.07741018
Minimum	0.5	Data not normal at 5% significance level	
Maximum	4000		
Mean	100.177557	95% UCL (Assuming Normal Distribution)	
Median	22	Student's-t UCL	153.330157
Standard Deviation	367.22057		
Variance	134850.947		
Coefficient of Variation	3.66569699	Gamma Distribution Test	
Skewness	9.50071397	A-D Test Statistic	5.44619201
Gamma Statistics			
k hat	0.43255584	A-D 5% Critical Value	0.83568695
k star (bias corrected)	0.42773904	K-S Test Statistic	0.1392773
Theta hat	231.594509	K-S 5% Critical Value	0.08691404
Theta star	234.202512	Data do not follow gamma distribution	
nu hat	113.32963	at 5% significance level	
nu star	112.067628	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	88.6259968	Approximate Gamma UCL	126.674584
Adjusted Level of Significance	0.04816794	Adjusted Gamma UCL	127.004842
Adjusted Chi Square Value	88.3955372		
Log-transformed Statistics			
Minimum of log data	-0.69314718	Lognormal Distribution Test	
Maximum of log data	8.29404964	Lilliefors Test Statistic	0.10099354
Mean of log data	3.10463065	Lilliefors 5% Critical Value	0.07741018
Standard Deviation of log data	1.68303451	Data not lognormal at 5% significance level	
Variance of log data	2.83260517	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	140.403942
		95% Chebyshev (MVUE) UCL	174.530309
		97.5% Chebyshev (MVUE) UCL	211.271801
		99% Chebyshev (MVUE) UCL	283.443348
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 97.5% Chebyshev (Mean, Sd) UCL		CLT UCL	152.951387
All units are in milligrams/kilogram (mg/kg)		Adj-CLT UCL (Adjusted for skewness)	181.4086
		Mod-t UCL (Adjusted for skewness)	157.768907
		Jackknife UCL	153.330157
		Standard Bootstrap UCL	152.550077
		Bootstrap-t UCL	251.954659
		Hall's Bootstrap UCL	348.184777
		Percentile Bootstrap UCL	157.989542
		BCA Bootstrap UCL	201.490458
		95% Chebyshev (Mean, Sd) UCL	240.029387
		97.5% Chebyshev (Mean, Sd) UCL	300.543385
		99% Chebyshev (Mean, Sd) UCL	419.411418

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Indeno(1,2,3-c,d)pyrene

Raw Statistics			
Number of Valid Samples	132	Lilliefors Test Statistic	0.46267707
Number of Unique Samples	71	Lilliefors 5% Critical Value	0.0771164
Minimum	11.3	Data not normal at 5% significance level	
Maximum	1200000		
Mean	52584.2455	95% UCL (Assuming Normal Distribution)	
Median	155	Student's-t UCL	81235.0741
Standard Deviation	198707.752		
Variance	3.95E+10		
Coefficient of Variation	3.77884575	Gamma Distribution Test	
Skewness	4.41134159	A-D Test Statistic	19.4096657
Gamma Statistics			
k hat	0.15080988	A-D 5% Critical Value	0.97847347
k star (bias corrected)	0.15243289	K-S Test Statistic	0.28066171
Theta hat	348679.043	K-S 5% Critical Value	0.09202282
Theta star	344966.532	Data do not follow gamma distribution	
nu hat	39.8138089	at 5% significance level	
nu star	40.2422829	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	26.7044963	Approximate Gamma UCL	79241.7149
Adjusted Level of Significance	0.04818182	Adjusted Gamma UCL	79604.0282
Adjusted Chi Square Value	26.5829523		
Log-transformed Statistics			
Minimum of log data	2.42480273	Lognormal Distribution Test	
Maximum of log data	13.9978321	Lilliefors Test Statistic	0.15984382
Mean of log data	5.77780445	Lilliefors 5% Critical Value	0.0771164
Standard Deviation of log data	3.10517331	Data not lognormal at 5% significance level	
Variance of log data	9.64210131	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	139793.698
		95% Chebyshev (MVUE) UCL	109685.427
		97.5% Chebyshev (MVUE) UCL	142862.062
		99% Chebyshev (MVUE) UCL	208031.138
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	81032.4657
All units are in micrograms/kilogram ($\mu\text{g/kg}$)		Adj-CLT UCL (Adjusted for skewness)	88128.1124
		Mod-t UCL (Adjusted for skewness)	82341.8516
		Jackknife UCL	81235.0741
		Standard Bootstrap UCL	81396.229
		Bootstrap-t UCL	94435.0416
		Hall's Bootstrap UCL	86898.0564
		Percentile Bootstrap UCL	83489.2417
		BCA Bootstrap UCL	89383.6652
		95% Chebyshev (Mean, Sd) UCL	127972.666
		97.5% Chebyshev (Mean, Sd) UCL	160593.296
		99% Chebyshev (Mean, Sd) UCL	224670.207

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Fluoranthene

Raw Statistics			
Number of Valid Samples	132	Lilliefors Test Statistic	0.47956674
Number of Unique Samples	85	Lilliefors 5% Critical Value	0.0771164
Minimum	18.5	Data not normal at 5% significance level	
Maximum	5400000		
Mean	207198.737	95% UCL (Assuming Normal Distribution)	
Median	357.5	Student's-t UCL	318647.827
Standard Deviation	772954.894		
Variance	5.97E+11		
Coefficient of Variation	3.73050002	Gamma Distribution Test	
Skewness	4.58304162	A-D Test Statistic	19.6293356
Gamma Statistics			
k hat	0.13455152	A-D 5% Critical Value	1.00014092
k star (bias corrected)	0.13654404	K-S Test Statistic	0.30934369
Theta hat	1539921.15	K-S 5% Critical Value	0.09271308
Theta star	1517449.89	Data do not follow gamma distribution	
nu hat	35.5216022	at 5% significance level	
nu star	36.0476264	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	23.3047823	Approximate Gamma UCL	320493.132
Adjusted Level of Significance	0.04818182	Adjusted Gamma UCL	322054.493
Adjusted Chi Square Value	23.1917977		
Log-transformed Statistics			
Minimum of log data	2.91777073	Lognormal Distribution Test	
Maximum of log data	15.5019095	Lilliefors Test Statistic	0.15155101
Mean of log data	6.43983132	Lilliefors 5% Critical Value	0.0771164
Standard Deviation of log data	3.42012687	Data not lognormal at 5% significance level	
Variance of log data	11.6972678	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	970962.981
		95% Chebyshev (MVUE) UCL	601494.749
		97.5% Chebyshev (MVUE) UCL	790203.052
		99% Chebyshev (MVUE) UCL	1160883.97
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	317859.699
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	346535.426
		Mod-t UCL (Adjusted for skewness)	323120.661
		Jackknife UCL	318647.827
		Standard Bootstrap UCL	317804.378
		Bootstrap-t UCL	376139.183
		Hall's Bootstrap UCL	348268.668
		Percentile Bootstrap UCL	323457.071
		BCA Bootstrap UCL	351450.56
		95% Chebyshev (Mean, Sd) UCL	500452.765
		97.5% Chebyshev (Mean, Sd) UCL	627344.017
		99% Chebyshev (Mean, Sd) UCL	876597.311

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Benzo(a)anthracene

Raw Statistics			
Number of Valid Samples	132	Lilliefors Test Statistic	0.47777252
Number of Unique Samples	80	Lilliefors 5% Critical Value	0.0771164
Minimum	17	Data not normal at 5% significance level	
Maximum	2400000		
Mean	130008.924	95% UCL (Assuming Normal Distribution)	
Median	236.5	Student's-t UCL	199482.588
Standard Deviation	481834.429		
Variance	2.32E+11		
Coefficient of Variation	3.70616429	Gamma Distribution Test	
Skewness	3.97987394	A-D Test Statistic	20.3204602
Gamma Statistics			
k hat	0.13761233	A-D 5% Critical Value	0.99606179
k star (bias corrected)	0.13953528	K-S Test Statistic	0.30371775
Theta hat	944747.616	K-S 5% Critical Value	0.09258313
Theta star	931727.939	Data do not follow gamma distribution	
nu hat	36.3296559	at 5% significance level	
nu star	36.8373152	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	23.9413771	Approximate Gamma UCL	200037.77
Adjusted Level of Significance	0.04818182	Adjusted Gamma UCL	201000.166
Adjusted Chi Square Value	23.826745		
Log-transformed Statistics			
Minimum of log data	2.83321334	Lognormal Distribution Test	
Maximum of log data	14.6909793	Lilliefors Test Statistic	0.15943982
Mean of log data	6.12075941	Lilliefors 5% Critical Value	0.0771164
Standard Deviation of log data	3.29822293	Data not lognormal at 5% significance level	
Variance of log data	10.8782745	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	424388.089
		95% Chebyshev (MVUE) UCL	289987.691
		97.5% Chebyshev (MVUE) UCL	379786.897
		99% Chebyshev (MVUE) UCL	556180.05
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	198991.295
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	214514.222
		Mod-t UCL (Adjusted for skewness)	201903.851
		Jackknife UCL	199482.588
		Standard Bootstrap UCL	200015.861
		Bootstrap-t UCL	224642.826
		Hall's Bootstrap UCL	201269.415
		Percentile Bootstrap UCL	202977.55
		BCA Bootstrap UCL	223214.641
		95% Chebyshev (Mean, Sd) UCL	312813.752
		97.5% Chebyshev (Mean, Sd) UCL	391913.548
		99% Chebyshev (Mean, Sd) UCL	547289.78

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Pyrene

Raw Statistics			
Number of Valid Samples	145	Lilliefors Test Statistic	0.47915194
Number of Unique Samples	90	Lilliefors 5% Critical Value	0.0735783
Minimum	10	Data not normal at 5% significance level	
Maximum	8400000		
Mean	284577.952	95% UCL (Assuming Normal Distribution)	
Median	330	Student's-t UCL	444141.616
Standard Deviation	1160613.97		
Variance	1.35E+12		
Coefficient of Variation	4.07836925	Gamma Distribution Test	
Skewness	5.15915181	A-D Test Statistic	21.1727346
Gamma Statistics			
k hat	0.12588668	A-D 5% Critical Value	1.0198148
k star (bias corrected)	0.12787983	K-S Test Statistic	0.29220598
Theta hat	2260588.21	K-S 5% Critical Value	0.08944552
Theta star	2225354.44	Data do not follow gamma distribution	
nu hat	36.5071382	at 5% significance level	
nu star	37.0851514	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	24.141509	Approximate Gamma UCL	437156.453
Adjusted Level of Significance	0.04834483	Adjusted Gamma UCL	439060.584
Adjusted Chi Square Value	24.0368114		
Log-transformed Statistics			
Minimum of log data	2.30258509	Lognormal Distribution Test	
Maximum of log data	15.9437423	Lilliefors Test Statistic	0.13755158
Mean of log data	6.30022112	Lilliefors 5% Critical Value	0.0735783
Standard Deviation of log data	3.61525157	Data not lognormal at 5% significance level	
Variance of log data	13.0700439	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	1812311.11
		95% Chebyshev (MVUE) UCL	1037657.49
		97.5% Chebyshev (MVUE) UCL	1366910.65
		99% Chebyshev (MVUE) UCL	2013664.74
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	443115.104
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	487239.473
		Mod-t UCL (Adjusted for skewness)	451024.126
		Jackknife UCL	444141.616
		Standard Bootstrap UCL	442286.05
		Bootstrap-t UCL	529251.633
		Hall's Bootstrap UCL	499425.752
		Percentile Bootstrap UCL	452073.608
		BCA Bootstrap UCL	501099.588
		95% Chebyshev (Mean, Sd) UCL	704704.953
		97.5% Chebyshev (Mean, Sd) UCL	886494.242
		99% Chebyshev (Mean, Sd) UCL	1243584.1

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Benzo(a)pyrene

Raw Statistics			
Number of Valid Samples	145	Lilliefors Test Statistic	0.46133175
Number of Unique Samples	80	Lilliefors 5% Critical Value	0.0735783
Minimum	10	Data not normal at 5% significance level	
Maximum	2600000		
Mean	95887.04	95% UCL (Assuming Normal Distribution)	
Median	176	Student's-t UCL	147210.746
Standard Deviation	373311.873		
Variance	1.39E+11	Gamma Distribution Test	
Coefficient of Variation	3.8932464	A-D Test Statistic	20.0424633
Skewness	4.58688256	A-D 5% Critical Value	0.99872417
		K-S Test Statistic	0.27809661
		K-S 5% Critical Value	0.08880746
Gamma Statistics			
k hat	0.14054303	Data do not follow gamma distribution	
k star (bias corrected)	0.14223295	at 5% significance level	
Theta hat	682261.061		
Theta star	674154.903	95% UCLs (Assuming Gamma Distribution)	
nu hat	40.7574801	Approximate Gamma UCL	143688.451
nu star	41.2475552	Adjusted Gamma UCL	144277.18
Approx.Chi Square Value (.05)	27.5255663		
Adjusted Level of Significance	0.04834483	Lognormal Distribution Test	
Adjusted Chi Square Value	27.4132471	Lilliefors Test Statistic	0.14057227
		Lilliefors 5% Critical Value	0.0735783
		Data not lognormal at 5% significance level	
Log-transformed Statistics			
Minimum of log data	2.30258509		
Maximum of log data	14.771022	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	5.95078323	95% H-UCL	426172.974
Standard Deviation of log data	3.35896669	95% Chebyshev (MVUE) UCL	299779.414
Variance of log data	11.2826572	97.5% Chebyshev (MVUE) UCL	392459.937
		99% Chebyshev (MVUE) UCL	574512.877
95% Non-parametric UCLs			
		CLT UCL	146880.568
		Adj-CLT UCL (Adjusted for skewness)	159498.897
		Mod-t UCL (Adjusted for skewness)	149178.95
		Jackknife UCL	147210.746
		Standard Bootstrap UCL	147364.03
		Bootstrap-t UCL	169187.077
		Hall's Bootstrap UCL	155284.979
		Percentile Bootstrap UCL	151220.809
		BCA Bootstrap UCL	162485.761
		95% Chebyshev (Mean, Sd) UCL	231021.031
		97.5% Chebyshev (Mean, Sd) UCL	289493.616
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		99% Chebyshev (Mean, Sd) UCL	404351.689

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Naphthalene

Raw Statistics			
Number of Valid Samples	158	Lilliefors Test Statistic	0.47734366
Number of Unique Samples	74	Lilliefors 5% Critical Value	0.07048638
Minimum	10	Data not normal at 5% significance level	
Maximum	37000000		
Mean	766186.864	95% UCL (Assuming Normal Distribution)	
Median	76	Student's-t UCL	1333213.19
Standard Deviation	4307590.13		
Variance	1.86E+13		
Coefficient of Variation	5.62211431	Gamma Distribution Test	
Skewness	6.57611487	A-D Test Statistic	33.3152317
Gamma Statistics			
k hat	0.10168495	A-D 5% Critical Value	1.0653406
k star (bias corrected)	0.10397363	K-S Test Statistic	0.36726697
Theta hat	7534909.07	K-S 5% Critical Value	0.08688983
Theta star	7369049.58	Data do not follow gamma distribution	
nu hat	32.1324447	at 5% significance level	
nu star	32.8556683	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	20.7496377	Approximate Gamma UCL	1213205.83
Adjusted Level of Significance	0.04848101	Adjusted Gamma UCL	1218401.28
Adjusted Chi Square Value	20.6611582	Lognormal Distribution Test	
Log-transformed Statistics			
Minimum of log data	2.30258509	Lilliefors Test Statistic	0.17921976
Maximum of log data	17.4264285	Lilliefors 5% Critical Value	0.07048638
Mean of log data	5.57941793	Data not lognormal at 5% significance level	
Standard Deviation of log data	3.56820331	95% UCLs (Assuming Lognormal Distribution)	
Variance of log data	12.7320748	95% H-UCL	663827.137
		95% Chebyshev (MVUE) UCL	428274.082
		97.5% Chebyshev (MVUE) UCL	562624.942
		99% Chebyshev (MVUE) UCL	826531.191
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	1329867.46
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	1521437.28
		Mod-t UCL (Adjusted for skewness)	1363094.21
		Jackknife UCL	1333213.19
		Standard Bootstrap UCL	1324292.2
		Bootstrap-t UCL	1961367.47
		Hall's Bootstrap UCL	1285995.47
		Percentile Bootstrap UCL	1391431.15
		BCA Bootstrap UCL	1541112.4
		95% Chebyshev (Mean, Sd) UCL	2259953.07
		97.5% Chebyshev (Mean, Sd) UCL	2906306.9
		99% Chebyshev (Mean, Sd) UCL	4175943.85

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Acenaphthylene

Raw Statistics			
Number of Valid Samples	122	Lilliefors Test Statistic	0.48097967
Number of Unique Samples	60	Lilliefors 5% Critical Value	0.08021467
Minimum	15.5	Data not normal at 5% significance level	
Maximum	9700000		
Mean	324904.373	95% UCL (Assuming Normal Distribution)	
Median	155	Student's-t UCL	549983.659
Standard Deviation	1499858.85		
Variance	2.25E+12		
Coefficient of Variation	4.61630859	Gamma Distribution Test	
Skewness	5.18736351	A-D Test Statistic	22.9007769
Gamma Statistics			
k hat	0.11573805	A-D 5% Critical Value	1.01813262
k star (bias corrected)	0.11835652	K-S Test Statistic	0.32749624
Theta hat	2807238.94	K-S 5% Critical Value	0.09629989
Theta star	2745132.93	Data do not follow gamma distribution	
nu hat	28.2400852	at 5% significance level	
nu star	28.8789902	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	17.6119179	Approximate Gamma UCL	532759.138
Adjusted Level of Significance	0.04803279	Adjusted Gamma UCL	535960.6
Adjusted Chi Square Value	17.5067164		
Log-transformed Statistics			
Minimum of log data	2.74084002	Lognormal Distribution Test	
Maximum of log data	16.0876364	Lilliefors Test Statistic	0.18711268
Mean of log data	5.80608619	Lilliefors 5% Critical Value	0.08021467
Standard Deviation of log data	3.44957604	Data not lognormal at 5% significance level	
Variance of log data	11.8995749	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	626885.922
		95% Chebyshev (MVUE) UCL	351608.849
		97.5% Chebyshev (MVUE) UCL	462937.508
		99% Chebyshev (MVUE) UCL	681621.101
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	548260.429
All units are in micrograms/kilogram ($\mu\text{g/kg}$)		Adj-CLT UCL (Adjusted for skewness)	616402.865
		Mod-t UCL (Adjusted for skewness)	560612.502
		Jackknife UCL	549983.659
		Standard Bootstrap UCL	549859.297
		Bootstrap-t UCL	694332.939
		Hall's Bootstrap UCL	533141.051
		Percentile Bootstrap UCL	555338.271
		BCA Bootstrap UCL	616758.586
		95% Chebyshev (Mean, Sd) UCL	916802.921
		97.5% Chebyshev (Mean, Sd) UCL	1172917.9
		99% Chebyshev (Mean, Sd) UCL	1676006.17

Attachment F2
ProUCL Summary Tables
Construction Worker Receptor Exposed to Surface and Subsurface Soils (0-4 feet)
Vanadium

Raw Statistics			
Number of Valid Samples	90	Lilliefors Test Statistic	0.13100882
Number of Unique Samples	38	Lilliefors 5% Critical Value	0.0933926
Minimum	8.8	Data not normal at 5% significance level	
Maximum	110		
Mean	28.6877778	95% UCL (Assuming Normal Distribution)	
Median	29	Student's-t UCL	31.2724912
Standard Deviation	14.7523819		
Variance	217.63277	Gamma Distribution Test	
Coefficient of Variation	0.51423927	A-D Test Statistic	0.91871705
Skewness	2.1911587	A-D 5% Critical Value	0.75500854
Gamma Statistics			
k hat	4.62136899	K-S Test Statistic	0.09323588
k star (bias corrected)	4.47473077	K-S 5% Critical Value	0.09446272
Theta hat	6.20763627	Data follow approximate gamma distribution	
Theta star	6.41106231	at 5% significance level	
nu hat	831.846419	95% UCLs (Assuming Gamma Distribution)	
nu star	805.451538	Approximate Gamma UCL	31.20085
Approx.Chi Square Value (.05)	740.576449	Adjusted Gamma UCL	31.2431476
Adjusted Level of Significance	0.04733333	Lognormal Distribution Test	
Adjusted Chi Square Value	739.573844	Lilliefors Test Statistic	0.12412091
Log-transformed Statistics			
Minimum of log data	2.17475172	Lilliefors 5% Critical Value	0.0933926
Maximum of log data	4.70048037	Data not lognormal at 5% significance level	
Mean of log data	3.24439409	95% UCLs (Assuming Lognormal Distribution)	
Standard Deviation of log data	0.47587483	95% H-UCL	31.4867895
Variance of log data	0.22645685	95% Chebyshev (MVUE) UCL	35.2641285
		97.5% Chebyshev (MVUE) UCL	38.1127502
		99% Chebyshev (MVUE) UCL	43.7083159
RECOMMENDATION			
Assuming gamma distribution (0.05)		95% Non-parametric UCLs	
Use Approximate Gamma UCL		CLT UCL	31.245587
All units are in milligrams/kilogram (mg/kg)		Adj-CLT UCL (Adjusted for skewness)	31.6293595
		Mod-t UCL (Adjusted for skewness)	31.332352
		Jackknife UCL	31.2724912
		Standard Bootstrap UCL	31.2362163
		Bootstrap-t UCL	31.8040909
		Hall's Bootstrap UCL	32.2314217
		Percentile Bootstrap UCL	31.2755556
		BCA Bootstrap UCL	31.7977778
		95% Chebyshev (Mean, Sd) UCL	35.4660295
		97.5% Chebyshev (Mean, Sd) UCL	38.3989844
		99% Chebyshev (Mean, Sd) UCL	44.1602064

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
1,2,4-Trimethylbenzene (0-3ft)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.2484836
Number of Unique Samples	14	Shapiro-Wilk 5% Critical Value	0.94
Minimum	7.5	Data not normal at 5% significance level	
Maximum	15000		
Mean	613.3375	95% UCL (Assuming Normal Distribution)	
Median	7.5	Student's-t UCL	1334.3886
Standard Deviation	2706.6269		
Variance	7325829	Gamma Distribution Test	
Coefficient of Variation	4.4129486	A-D Test Statistic	11.399515
Skewness	4.7623151	A-D 5% Critical Value	0.9001207
		K-S Test Statistic	0.4161673
		K-S 5% Critical Value	0.1542412
Gamma Statistics			
k hat	0.2060006	Data do not follow gamma distribution	
k star (bias corrected)	0.2072172	at 5% significance level	
Theta hat	2977.358		
Theta star	2959.8772	95% UCLs (Assuming Gamma Distribution)	
nu hat	16.480047	Approximate Gamma UCL	1214.7939
nu star	16.577377	Adjusted Gamma UCL	1247.4483
Approx.Chi Square Value (.05)	8.3697549		
Adjusted Level of Significance	0.044	Lognormal Distribution Test	
Adjusted Chi Square Value	8.1506601	Shapiro-Wilk Test Statistic	0.5566592
		Shapiro-Wilk 5% Critical Value	0.94
		Data not lognormal at 5% significance level	
Log-transformed Statistics			
Minimum of log data	2.014903		
Maximum of log data	9.6158055	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	2.8629751	95% H-UCL	200.1478
Standard Deviation of log data	1.7393527	95% Chebyshev (MVUE) UCL	191.69961
Variance of log data	3.0253479	97.5% Chebyshev (MVUE) UCL	243.10381
		99% Chebyshev (MVUE) UCL	344.07742
95% Non-parametric UCLs			
		CLT UCL	1317.2613
		Adj-CLT UCL (Adjusted for skewness)	1661.585
		Mod-t UCL (Adjusted for skewness)	1388.0961
		Jackknife UCL	1334.3886
		Standard Bootstrap UCL	1309.5471
		Bootstrap-t UCL	52671.997
		Hall's Bootstrap UCL	45047.972
		Percentile Bootstrap UCL	1365.9375
		BCA Bootstrap UCL	1739.2
RECOMMENDATION		95% Chebyshev (Mean, Sd) UCL	2478.7513
Data are Non-parametric (0.05)		97.5% Chebyshev (Mean, Sd) UCL	3285.9174
Use 99% Chebyshev (Mean, Sd) UCL		99% Chebyshev (Mean, Sd) UCL	4871.4388
All units are in micrograms/kilogram ($\mu\text{g/kg}$)			

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
1,3,5-Trimethylbenzene (0-3ft)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.26142057
Number of Unique Samples	5	Shapiro-Wilk 5% Critical Value	0.94
Minimum	8	Data not normal at 5% significance level	
Maximum	5400		
Mean	232.8	95% UCL (Assuming Normal Distribution)	
Median	8	Student's-t UCL	491.622884
Standard Deviation	971.549732		
Variance	943908.882		
Coefficient of Variation	4.17332359	Gamma Distribution Test	
Skewness	4.74240511	A-D Test Statistic	13.7192926
Gamma Statistics			
k hat	0.24544169	A-D 5% Critical Value	0.88231308
k star (bias corrected)	0.24370023	K-S Test Statistic	0.55922326
Theta hat	948.494111	K-S 5% Critical Value	0.15306584
Theta star	955.271966	Data do not follow gamma distribution	
nu hat	19.6353354	at 5% significance level	
nu star	19.4960186	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	10.4790035	Approximate Gamma UCL	433.120681
Adjusted Level of Significance	0.044	Adjusted Gamma UCL	443.639278
Adjusted Chi Square Value	10.2305484		
Log-transformed Statistics			
Minimum of log data	2.07944154	Lognormal Distribution Test	
Maximum of log data	8.59415423	Shapiro-Wilk Test Statistic	0.35128409
Mean of log data	2.547663	Shapiro-Wilk 5% Critical Value	0.94
Standard Deviation of log data	1.52230197	Data not lognormal at 5% significance level	
Variance of log data	2.31740328	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	84.9584884
		95% Chebyshev (MVUE) UCL	91.0735805
		97.5% Chebyshev (MVUE) UCL	113.862084
		99% Chebyshev (MVUE) UCL	158.625685
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	485.475014
All units are in micrograms/kilogram ($\mu\text{g/kg}$)		Adj-CLT UCL (Adjusted for skewness)	608.554056
		Mod-t UCL (Adjusted for skewness)	510.820727
		Jackknife UCL	491.622884
		Standard Bootstrap UCL	479.499899
		Bootstrap-t UCL	3204.32156
		Hall's Bootstrap UCL	3886.93638
		Percentile Bootstrap UCL	505.7
		BCA Bootstrap UCL	657.65
		95% Chebyshev (Mean, Sd) UCL	902.394444
		97.5% Chebyshev (Mean, Sd) UCL	1192.12849
		99% Chebyshev (Mean, Sd) UCL	1761.25493

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
1-Methylnaphthalene (0-3ft)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.21120548
Number of Unique Samples	14	Shapiro-Wilk 5% Critical Value	0.94
Minimum	16	Data not normal at 5% significance level	
Maximum	230000		
Mean	7205.6875	95% UCL (Assuming Normal Distribution)	
Median	31.5	Student's-t UCL	17104.7707
Standard Deviation	37158.42846		
Variance	1380748806	Gamma Distribution Test	
Coefficient of Variation	5.156819313	A-D Test Statistic	10.8857694
Skewness	5.8679174	A-D 5% Critical Value	0.9262601
		K-S Test Statistic	0.46537446
		K-S 5% Critical Value	0.15586107
Gamma Statistics			
k hat	0.160733875	Data do not follow gamma distribution	
k star (bias corrected)	0.165345501	at 5% significance level	
Theta hat	44829.92468		
Theta star	43579.58011	95% UCLs (Assuming Gamma Distribution)	
nu hat	12.85870998	Approximate Gamma UCL	15767.4069
nu star	13.22764007	Adjusted Gamma UCL	16257.3017
Approx.Chi Square Value (.05)	6.045016867		
Adjusted Level of Significance	0.044	Lognormal Distribution Test	
Adjusted Chi Square Value	5.862857342	Shapiro-Wilk Test Statistic	0.6632246
		Shapiro-Wilk 5% Critical Value	0.94
		Data not lognormal at 5% significance level	
Log-transformed Statistics			
Minimum of log data	2.772588722		
Maximum of log data	12.34583459	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	4.149189138	95% H-UCL	1670.64634
Standard Deviation of log data	2.029651026	95% Chebyshev (MVUE) UCL	1290.22717
Variance of log data	4.119483289	97.5% Chebyshev (MVUE) UCL	1661.36575
		99% Chebyshev (MVUE) UCL	2390.39563
95% Non-parametric UCLs			
		CLT UCL	16869.6358
		Adj-CLT UCL (Adjusted for skewness)	22694.1775
		Mod-t UCL (Adjusted for skewness)	18013.2815
		Jackknife UCL	17104.7707
		Standard Bootstrap UCL	16608.9212
		Bootstrap-t UCL	2118790.42
		Hall's Bootstrap UCL	1480369.76
		Percentile Bootstrap UCL	17378.5875
		BCA Bootstrap UCL	25814.6375
		95% Chebyshev (Mean, Sd) UCL	32815.367
		97.5% Chebyshev (Mean, Sd) UCL	43896.6957
		99% Chebyshev (Mean, Sd) UCL	65663.8203
RECOMMENDATION			
Data are Non-parametric (0.05)			
Use 99% Chebyshev (Mean, Sd) UCL			
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)			

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
Arsenic (0-3ft)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.81332856
Number of Unique Samples	37	Shapiro-Wilk 5% Critical Value	0.94
Minimum	0.325	Data not normal at 5% significance level	
Maximum	13		
Mean	2.970375	95% UCL (Assuming Normal Distribution)	
Median	2.1	Student's-t UCL	3.7671155
Standard Deviation	2.99074414		
Variance	8.9445505	Gamma Distribution Test	
Coefficient of Variation	1.00685743	A-D Test Statistic	0.62439236
Skewness	1.60788608	A-D 5% Critical Value	0.77605069
		K-S Test Statistic	0.12623353
		K-S 5% Critical Value	0.14336926
Gamma Statistics			
k hat	1.10376882	Data follow gamma distribution	
k star (bias corrected)	1.03765282	at 5% significance level	
Theta hat	2.6911206		
Theta star	2.86259039	95% UCLs (Assuming Gamma Distribution)	
nu hat	88.3015055	Approximate Gamma UCL	3.91326081
nu star	83.0122259	Adjusted Gamma UCL	3.9542392
Approx.Chi Square Value (.05)	63.0107351		
Adjusted Level of Significance	0.044	Lognormal Distribution Test	
Adjusted Chi Square Value	62.3577453	Shapiro-Wilk Test Statistic	0.92921742
		Shapiro-Wilk 5% Critical Value	0.94
		Data not lognormal at 5% significance level	
Log-transformed Statistics			
Minimum of log data	-1.1239301		
Maximum of log data	2.56494936	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	0.57159141	95% H-UCL	4.97678314
Standard Deviation of log data	1.09451021	95% Chebyshev (MVUE) UCL	5.98186692
Variance of log data	1.19795261	97.5% Chebyshev (MVUE) UCL	7.20700042
		99% Chebyshev (MVUE) UCL	9.61353794
95% Non-parametric UCLs			
		CLT UCL	3.74819037
		Adj-CLT UCL (Adjusted for skewness)	3.87664654
		Mod-t UCL (Adjusted for skewness)	3.78715207
		Jackknife UCL	3.7671155
		Standard Bootstrap UCL	3.73815095
		Bootstrap-t UCL	3.94941982
		Hall's Bootstrap UCL	3.90765963
		Percentile Bootstrap UCL	3.78175
		BCA Bootstrap UCL	3.88475
		95% Chebyshev (Mean, Sd) UCL	5.03160315
		97.5% Chebyshev (Mean, Sd) UCL	5.92349822
All units are in milligrams/kilogram (mg/kg)		99% Chebyshev (Mean, Sd) UCL	7.67545337

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
Benzo(a)anthracene (0-3ft)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.20334941
Number of Unique Samples	21	Shapiro-Wilk 5% Critical Value	0.94
Minimum	17	Data not normal at 5% significance level	
Maximum	190000		
Mean	5771.725	95% UCL (Assuming Normal Distribution)	
Median	83.5	Student's-t UCL	13817.2221
Standard Deviation	30200.5775		
Variance	912074884		
Coefficient of Variation	5.23250459	Gamma Distribution Test	
Skewness	6.13139117	A-D Test Statistic	7.23125163
Gamma Statistics			
k hat	0.19046437	A-D 5% Critical Value	0.90851991
k star (bias corrected)	0.19284621	K-S Test Statistic	0.32068251
Theta hat	30303.4366	K-S 5% Critical Value	0.15476996
Theta star	29929.1596	Data do not follow gamma distribution	
nu hat	15.2371497	at 5% significance level	
nu star	15.4276968	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	7.55877209	Approximate Gamma UCL	11780.2762
Adjusted Level of Significance	0.044	Adjusted Gamma UCL	12111.7287
Adjusted Chi Square Value	7.35191691		
Log-transformed Statistics			
Minimum of log data	2.83321334	Lognormal Distribution Test	
Maximum of log data	12.1547794	Shapiro-Wilk Test Statistic	0.82720329
Mean of log data	4.76749781	Shapiro-Wilk 5% Critical Value	0.94
Standard Deviation of log data	2.21636618	Data not lognormal at 5% significance level	
Variance of log data	4.91227906		
		95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	5675.75084
		95% Chebyshev (MVUE) UCL	3662.7293
		97.5% Chebyshev (MVUE) UCL	4753.84894
		99% Chebyshev (MVUE) UCL	6897.14221
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	13626.1159
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	18572.5781
		Mod-t UCL (Adjusted for skewness)	14588.7703
		Jackknife UCL	13817.2221
		Standard Bootstrap UCL	13584.3592
		Bootstrap-t UCL	291895.378
		Hall's Bootstrap UCL	178375.321
		Percentile Bootstrap UCL	15220.35
		BCA Bootstrap UCL	20703
		95% Chebyshev (Mean, Sd) UCL	26586.0367
		97.5% Chebyshev (Mean, Sd) UCL	35592.4059
		99% Chebyshev (Mean, Sd) UCL	53283.6744

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
Pyrene (0-3)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.18923659
Number of Unique Samples	24	Shapiro-Wilk 5% Critical Value	0.94
Minimum	18	Data not normal at 5% significance level	
Maximum	670000		
Mean	19099.1625	95% UCL (Assuming Normal Distribution)	
Median	175	Student's-t UCL	47344.263
Standard Deviation	1.06E+05		
Variance	1.12E+10		
Coefficient of Variation	5.55125485	Gamma Distribution Test	
Skewness	6.2416462	A-D Test Statistic	6.80227362
Gamma Statistics			
k hat	0.16719782	A-D 5% Critical Value	0.92240306
k star (bias corrected)	0.17132465	K-S Test Statistic	0.32210455
Theta hat	114230.932	K-S 5% Critical Value	0.15562384
Theta star	111479.362	Data do not follow gamma distribution	
nu hat	13.3758254	at 5% significance level	
nu star	13.7059719	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	6.36942889	Approximate Gamma UCL	41098.2819
Adjusted Level of Significance	0.044	Adjusted Gamma UCL	42346.0699
Adjusted Chi Square Value	6.18174448	Lognormal Distribution Test	
Log-transformed Statistics			
Minimum of log data	2.89037176	Shapiro-Wilk Test Statistic	0.86358359
Maximum of log data	13.415033	Shapiro-Wilk 5% Critical Value	0.94
Mean of log data	5.3336107	Data not lognormal at 5% significance level	
Standard Deviation of log data	2.52880785	95% UCLs (Assuming Lognormal Distribution)	
Variance of log data	6.39486916	95% H-UCL	30971.7382
		95% Chebyshev (MVUE) UCL	13701.8073
		97.5% Chebyshev (MVUE) UCL	17973.3281
		99% Chebyshev (MVUE) UCL	26363.9036
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	46673.3517
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	64351.0232
		Mod-t UCL (Adjusted for skewness)	50101.6225
		Jackknife UCL	47344.263
		Standard Bootstrap UCL	46978.1257
		Bootstrap-t UCL	1459311.23
		Hall's Bootstrap UCL	809303.404
		Percentile Bootstrap UCL	52417.55
		BCA Bootstrap UCL	75499.525
		95% Chebyshev (Mean, Sd) UCL	92171.3813
		97.5% Chebyshev (Mean, Sd) UCL	123789.789
		99% Chebyshev (Mean, Sd) UCL	185898.028

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
Dibenz(a,h)anthracene (0-3ft)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.29347434
Number of Unique Samples	10	Shapiro-Wilk 5% Critical Value	0.94
Minimum	17	Data not normal at 5% significance level	
Maximum	8500		
Mean	394.725	95% UCL (Assuming Normal Distribution)	
Median	34	Student's-t UCL	781.024539
Standard Deviation	1450.06194		
Variance	2102679.64		
Coefficient of Variation	3.67360047	Gamma Distribution Test	
Skewness	5.05090365	A-D Test Statistic	7.0848659
Gamma Statistics			
k hat	0.33476519	A-D 5% Critical Value	0.84993431
k star (bias corrected)	0.32632447	K-S Test Statistic	0.33464504
Theta hat	1179.11004	K-S 5% Critical Value	0.15076556
Theta star	1209.60895	Data do not follow gamma distribution	
nu hat	26.7812156	at 5% significance level	
nu star	26.1059577	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	15.459147	Approximate Gamma UCL	666.574562
Adjusted Level of Significance	0.044	Adjusted Gamma UCL	680.121715
Adjusted Chi Square Value	15.1512206		
Log-transformed Statistics			
Minimum of log data	2.83321334	Lognormal Distribution Test	
Maximum of log data	9.04782144	Shapiro-Wilk Test Statistic	0.74994656
Mean of log data	3.95488067	Shapiro-Wilk 5% Critical Value	0.94
Standard Deviation of log data	1.5278663	Data not lognormal at 5% significance level	
Variance of log data	2.33437543	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	351.557859
		95% Chebyshev (MVUE) UCL	375.960787
		97.5% Chebyshev (MVUE) UCL	470.22173
		99% Chebyshev (MVUE) UCL	655.3791
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	771.848691
All units are in micrograms/kilogram ($\mu\text{g/kg}$)		Adj-CLT UCL (Adjusted for skewness)	967.496984
		Mod-t UCL (Adjusted for skewness)	811.541719
		Jackknife UCL	781.024539
		Standard Bootstrap UCL	761.302133
		Bootstrap-t UCL	3817.9069
		Hall's Bootstrap UCL	2497.25376
		Percentile Bootstrap UCL	814.275
		BCA Bootstrap UCL	1123.75
		95% Chebyshev (Mean, Sd) UCL	1394.11123
		97.5% Chebyshev (Mean, Sd) UCL	1826.54645
		99% Chebyshev (Mean, Sd) UCL	2675.9817

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
Indeno(1,2,3-c,d)pyrene (0-3ft)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.23214832
Number of Unique Samples	17	Shapiro-Wilk 5% Critical Value	0.94
Minimum	15.5	Data not normal at 5% significance level	
Maximum	45000		
Mean	1544.4875	95% UCL (Assuming Normal Distribution)	
Median	31	Student's-t UCL	3454.58933
Standard Deviation	7169.99555		
Variance	51408836.1		
Coefficient of Variation	4.64231374	Gamma Distribution Test	
Skewness	6.01783026	A-D Test Statistic	7.15727483
Gamma Statistics			
k hat	0.23381413	A-D 5% Critical Value	0.88756292
k star (bias corrected)	0.23294474	K-S Test Statistic	0.34493939
Theta hat	6605.62085	K-S 5% Critical Value	0.15341234
Theta star	6630.27425	Data do not follow gamma distribution	
nu hat	18.7051305	at 5% significance level	
nu star	18.6355791	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	9.8503372	Approximate Gamma UCL	2921.97296
Adjusted Level of Significance	0.044	Adjusted Gamma UCL	2994.95407
Adjusted Chi Square Value	9.61030395		
Log-transformed Statistics			
Minimum of log data	2.74084002	Lognormal Distribution Test	
Maximum of log data	10.7144178	Shapiro-Wilk Test Statistic	0.78609693
Mean of log data	4.27176549	Shapiro-Wilk 5% Critical Value	0.94
Standard Deviation of log data	1.9441683	Data not lognormal at 5% significance level	
Variance of log data	3.77979036		
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	3409.21831
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	4561.81998
		Mod-t UCL (Adjusted for skewness)	3634.3719
		Jackknife UCL	3454.58933
		Standard Bootstrap UCL	3391.97213
		Bootstrap-t UCL	18244.9302
		Hall's Bootstrap UCL	13934.6091
		Percentile Bootstrap UCL	3727.1625
		BCA Bootstrap UCL	5099
		95% Chebyshev (Mean, Sd) UCL	6486.06591
		97.5% Chebyshev (Mean, Sd) UCL	8624.29083
		99% Chebyshev (Mean, Sd) UCL	12824.4197

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
Fluoranthene (0-3ft)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.19030753
Number of Unique Samples	25	Shapiro-Wilk 5% Critical Value	0.94
Minimum	18.5	Data not normal at 5% significance level	
Maximum	390000		
Mean	11182.175	95% UCL (Assuming Normal Distribution)	
Median	110	Student's-t UCL	27633.6363
Standard Deviation	61754.2489		
Variance	3813587257	Gamma Distribution Test	
Coefficient of Variation	5.522561478	A-D Test Statistic	7.2713734
Skewness	6.227491779	A-D 5% Critical Value	0.9170242
		K-S Test Statistic	0.33085177
		K-S 5% Critical Value	0.15529301
Gamma Statistics			
k hat	0.176212171	Data do not follow gamma distribution	
k star (bias corrected)	0.179662925	at 5% significance level	
Theta hat	63458.58485		
Theta star	62239.74709	95% UCLs (Assuming Gamma Distribution)	
nu hat	14.09697367	Approximate Gamma UCL	23544.2492
nu star	14.37303398	Adjusted Gamma UCL	24237.4608
Approx.Chi Square Value (.05)	6.82637106		
Adjusted Level of Significance	0.044	Lognormal Distribution Test	
Adjusted Chi Square Value	6.631131136	Shapiro-Wilk Test Statistic	0.84336088
		Shapiro-Wilk 5% Critical Value	0.94
		Data not lognormal at 5% significance level	
Log-transformed Statistics			
Minimum of log data	2.917770732		
Maximum of log data	12.87390202	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	5.063552213	95% H-UCL	11536.869
Standard Deviation of log data	2.33542629	95% Chebyshev (MVUE) UCL	6522.68582
Variance of log data	5.454215957	97.5% Chebyshev (MVUE) UCL	8503.12406
		99% Chebyshev (MVUE) UCL	12393.3115
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	27242.8615
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	37515.9358
		Mod-t UCL (Adjusted for skewness)	29236.0282
		Jackknife UCL	27633.6363
		Standard Bootstrap UCL	26466.06
		Bootstrap-t UCL	980684.875
		Hall's Bootstrap UCL	532416.418
		Percentile Bootstrap UCL	30577.875
		BCA Bootstrap UCL	50014.65
		95% Chebyshev (Mean, Sd) UCL	53743.3539
		97.5% Chebyshev (Mean, Sd) UCL	72159.61
		99% Chebyshev (Mean, Sd) UCL	108334.779

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
Benzo(a)pyrene (0-3ft)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.21406814
Number of Unique Samples	20	Shapiro-Wilk 5% Critical Value	0.94
Minimum	17	Data not normal at 5% significance level	
Maximum	220000		
Mean	6972.45	95% UCL (Assuming Normal Distribution)	
Median	85	Student's-t UCL	16297.1575
Standard Deviation	35002.38071		
Variance	1225166655	Gamma Distribution Test	
Coefficient of Variation	5.020097772	A-D Test Statistic	6.57786724
Skewness	6.09152635	A-D 5% Critical Value	0.90969964
		K-S Test Statistic	0.32345987
		K-S 5% Critical Value	0.15484252
Gamma Statistics			
k hat	0.188487277	Data do not follow gamma distribution	
k star (bias corrected)	0.191017398	at 5% significance level	
Theta hat	36991.62141		
Theta star	36501.6489	95% UCLs (Assuming Gamma Distribution)	
nu hat	15.07898218	Approximate Gamma UCL	14289.41
nu star	15.28139185	Adjusted Gamma UCL	14693.9136
Approx.Chi Square Value (.05)	7.456482833		
Adjusted Level of Significance	0.044	Lognormal Distribution Test	
Adjusted Chi Square Value	7.251215935	Shapiro-Wilk Test Statistic	0.83328497
		Shapiro-Wilk 5% Critical Value	0.94
		Data not lognormal at 5% significance level	
Log-transformed Statistics			
Minimum of log data	2.833213344		
Maximum of log data	12.30138283	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	4.9093192	95% H-UCL	11295.4279
Standard Deviation of log data	2.372489203	95% Chebyshev (MVUE) UCL	6110.83974
Variance of log data	5.628705016	97.5% Chebyshev (MVUE) UCL	7976.40727
		99% Chebyshev (MVUE) UCL	11640.9534
95% Non-parametric UCLs			
		CLT UCL	16075.666
		Adj-CLT UCL (Adjusted for skewness)	21771.327
		Mod-t UCL (Adjusted for skewness)	17185.5656
		Jackknife UCL	16297.1575
		Standard Bootstrap UCL	16129.8489
		Bootstrap-t UCL	177252.329
		Hall's Bootstrap UCL	117575.428
		Percentile Bootstrap UCL	17827.025
		BCA Bootstrap UCL	25992.225
		95% Chebyshev (Mean, Sd) UCL	31096.1761
		97.5% Chebyshev (Mean, Sd) UCL	41534.5317
All units are in micrograms/kilogram ($\mu\text{g/kg}$)		99% Chebyshev (Mean, Sd) UCL	62038.6599

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
Benzene (0-3ft)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.24375089
Number of Unique Samples	8	Shapiro-Wilk 5% Critical Value	0.94
Minimum	7.5	Data not normal at 5% significance level	
Maximum	25000		
Mean	891.7375	95% UCL (Assuming Normal Distribution)	
Median	7.5	Student's-t UCL	1976.17571
Standard Deviation	4070.682		
Variance	16570452		
Coefficient of Variation	4.56488821	Gamma Distribution Test	
Skewness	5.65837552	A-D Test Statistic	13.0322635
Gamma Statistics			
k hat	0.18213946	A-D 5% Critical Value	0.91348739
k star (bias corrected)	0.18514566	K-S Test Statistic	0.47631005
Theta hat	4895.90512	K-S 5% Critical Value	0.15507548
Theta star	4816.41038		
nu hat	14.5711566	95% UCLs (Assuming Gamma Distribution)	
nu star	14.8116532	Approximate Gamma UCL	1852.58824
Approx.Chi Square Value (.05)	7.12954248	Adjusted Gamma UCL	1906.08998
Adjusted Level of Significance	0.044		
Adjusted Chi Square Value	6.92942447	Lognormal Distribution Test	
		Shapiro-Wilk Test Statistic	0.41304453
		Shapiro-Wilk 5% Critical Value	0.94
		Data not lognormal at 5% significance level	
Log-transformed Statistics			
Minimum of log data	2.01490302	95% UCLs (Assuming Lognormal Distribution)	
Maximum of log data	10.1266311	95% H-UCL	261.448187
Mean of log data	2.69394106	95% Chebyshev (MVUE) UCL	225.02581
Standard Deviation of log data	1.89640789	97.5% Chebyshev (MVUE) UCL	287.872169
Variance of log data	3.59636288	99% Chebyshev (MVUE) UCL	411.321671
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	1950.41684
All units are in micrograms/kilogram ($\mu\text{g/kg}$)		Adj-CLT UCL (Adjusted for skewness)	2565.70615
		Mod-t UCL (Adjusted for skewness)	2072.14841
		Jackknife UCL	1976.17571
		Standard Bootstrap UCL	1930.08035
		Bootstrap-t UCL	4712.02531
		Hall's Bootstrap UCL	4979.98777
		Percentile Bootstrap UCL	2139.8875
		BCA Bootstrap UCL	3025.825
		95% Chebyshev (Mean, Sd) UCL	3697.26146
		97.5% Chebyshev (Mean, Sd) UCL	4911.21392
		99% Chebyshev (Mean, Sd) UCL	7295.78845

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
Naphthalene (0-3ft)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.20809109
Number of Unique Samples	13	Shapiro-Wilk 5% Critical Value	0.94
Minimum	15.5	Data not normal at 5% significance level	
Maximum	91000		
Mean	2815.7375	95% UCL (Assuming Normal Distribution)	
Median	30.5	Student's-t UCL	6699.68162
Standard Deviation	14579.2552		
Variance	212554682		
Coefficient of Variation	5.17777499	Gamma Distribution Test	
Skewness	5.99655251	A-D Test Statistic	9.8423071
Gamma Statistics			
k hat	0.19003325	A-D 5% Critical Value	0.90877716
k star (bias corrected)	0.19244742	K-S Test Statistic	0.41924945
Theta hat	14817.0781	K-S 5% Critical Value	0.15478578
Theta star	14631.204	Data do not follow gamma distribution	
nu hat	15.20266	at 5% significance level	
nu star	15.3957938	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	7.53644883	Approximate Gamma UCL	5752.11416
Adjusted Level of Significance	0.044	Adjusted Gamma UCL	5914.17089
Adjusted Chi Square Value	7.32993938		
Log-transformed Statistics			
Minimum of log data	2.74084002	Lognormal Distribution Test	
Maximum of log data	11.4186148	Shapiro-Wilk Test Statistic	0.70231267
Mean of log data	4.03955324	Shapiro-Wilk 5% Critical Value	0.94
Standard Deviation of log data	1.89585897	Data not lognormal at 5% significance level	
Variance of log data	3.59428124	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	1002.50625
		95% Chebyshev (MVUE) UCL	863.202966
		97.5% Chebyshev (MVUE) UCL	1104.25124
		99% Chebyshev (MVUE) UCL	1577.7439
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	6607.42555
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	8942.80472
		Mod-t UCL (Adjusted for skewness)	7063.95358
		Jackknife UCL	6699.68162
		Standard Bootstrap UCL	6460.36684
		Bootstrap-t UCL	249593.143
		Hall's Bootstrap UCL	168401.293
		Percentile Bootstrap UCL	7353.5375
		BCA Bootstrap UCL	9693.875
		95% Chebyshev (Mean, Sd) UCL	12863.7957
		97.5% Chebyshev (Mean, Sd) UCL	17211.5986
		99% Chebyshev (Mean, Sd) UCL	25752.0153

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
Benzo(k)fluoranthene (0-3ft)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.23682221
Number of Unique Samples	18	Shapiro-Wilk 5% Critical Value	0.94
Minimum	19	Data not normal at 5% significance level	
Maximum	56000		
Mean	1979.1	95% UCL (Assuming Normal Distribution)	
Median	38	Student's-t UCL	4396.83979
Standard Deviation	9075.52846		
Variance	82365216.8		
Coefficient of Variation	4.58568463	Gamma Distribution Test	
Skewness	5.76349365	A-D Test Statistic	7.01815248
Gamma Statistics			
k hat	0.23312662	A-D 5% Critical Value	0.88787333
k star (bias corrected)	0.23230879	K-S Test Statistic	0.29027076
Theta hat	8489.37818	K-S 5% Critical Value	0.15343283
Theta star	8519.26454	Data do not follow gamma distribution	
nu hat	18.6501292	at 5% significance level	
nu star	18.5847029	95% UCLs (Assuming Gamma Distribution)	
Approx.Chi Square Value (.05)	9.81333454	Approximate Gamma UCL	3748.06191
Adjusted Level of Significance	0.044	Adjusted Gamma UCL	3841.83563
Adjusted Chi Square Value	9.57380506		
Log-transformed Statistics			
Minimum of log data	2.94443898	Lognormal Distribution Test	
Maximum of log data	10.933107	Shapiro-Wilk Test Statistic	0.79864498
Mean of log data	4.50920872	Shapiro-Wilk 5% Critical Value	0.94
Standard Deviation of log data	1.94712275	Data not lognormal at 5% significance level	
Variance of log data	3.79128701	95% UCLs (Assuming Lognormal Distribution)	
		95% H-UCL	1863.82421
		95% Chebyshev (MVUE) UCL	1542.32655
		97.5% Chebyshev (MVUE) UCL	1978.15923
		99% Chebyshev (MVUE) UCL	2834.26814
RECOMMENDATION			
Data are Non-parametric (0.05)		95% Non-parametric UCLs	
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL	4339.41075
All units are in micrograms/kilogram ($\mu\text{g}/\text{kg}$)		Adj-CLT UCL (Adjusted for skewness)	5736.67377
		Mod-t UCL (Adjusted for skewness)	4614.78459
		Jackknife UCL	4396.83979
		Standard Bootstrap UCL	4225.49691
		Bootstrap-t UCL	46376.9584
		Hall's Bootstrap UCL	29436.7261
		Percentile Bootstrap UCL	4666.7
		BCA Bootstrap UCL	6536.625
		95% Chebyshev (Mean, Sd) UCL	8233.97634
		97.5% Chebyshev (Mean, Sd) UCL	10940.4663
		99% Chebyshev (Mean, Sd) UCL	16256.8418

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
Lead (0-3ft)

Raw Statistics		
Number of Valid Samples	40	Shapiro-Wilk Test Statistic
Number of Unique Samples	34	Shapiro-Wilk 5% Critical Value
Minimum	1.95	Data not normal at 5% significance level
Maximum	4000	
Mean	176.19375	95% UCL (Assuming Normal Distribution)
Median	28.5	Student's-t UCL
Standard Deviation	632.19336	
Variance	399668.44	Gamma Distribution Test
Coefficient of Variation	3.5880578	A-D Test Statistic
Skewness	5.966169	A-D 5% Critical Value
Gamma Statistics		
k hat	0.3313524	Data do not follow gamma distribution
k star (bias corrected)	0.3231677	at 5% significance level
Theta hat	531.74122	
Theta star	545.20846	95% UCLs (Assuming Gamma Distribution)
nu hat	26.508195	Approximate Gamma UCL
nu star	25.853414	Adjusted Gamma UCL
Approx.Chi Square Value (.05)	15.264718	
Adjusted Level of Significance	0.044	Lognormal Distribution Test
Adjusted Chi Square Value	14.958919	Shapiro-Wilk Test Statistic
Log-transformed Statistics		
Minimum of log data	0.6678294	95% UCLs (Assuming Lognormal Distribution)
Maximum of log data	8.2940496	95% H-UCL
Mean of log data	3.1240161	592.3865
Standard Deviation of log data	2.0258913	95% Chebyshev (MVUE) UCL
Variance of log data	4.1042356	458.99696
		97.5% Chebyshev (MVUE) UCL
		590.92655
		99% Chebyshev (MVUE) UCL
		850.07667
RECOMMENDATION		
Data are Non-parametric (0.05)		95% Non-parametric UCLs
Use 99% Chebyshev (Mean, Sd) UCL		CLT UCL
All units are in milligrams/kilogram (mg/kg)		340.61093
		Adj-CLT UCL (Adjusted for skewness)
		441.36577
		Mod-t UCL (Adjusted for skewness)
		360.3271
		Jackknife UCL
		344.61139
		Standard Bootstrap UCL
		340.58096
		Bootstrap-t UCL
		964.21134
		Hall's Bootstrap UCL
		880.1414
		Percentile Bootstrap UCL
		372.825
		BCA Bootstrap UCL
		473.495
		95% Chebyshev (Mean, Sd) UCL
		611.90295
		97.5% Chebyshev (Mean, Sd) UCL
		800.43467
		99% Chebyshev (Mean, Sd) UCL
		1170.7687

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface and Subsurface Soils (0-3 feet)
Benzo(b)fluoranthene (0-3ft)

Raw Statistics			
Number of Valid Samples	40	Shapiro-Wilk Test Statistic	0.23055716
Number of Unique Samples	22	Shapiro-Wilk 5% Critical Value	0.94
Minimum	19	Data not normal at 5% significance level	
Maximum	180000		
Mean	6121.8875	95% UCL (Assuming Normal Distribution)	
Median	107.5	Student's-t UCL	13800.0645
Standard Deviation	28821.7591		
Variance	830693797	Gamma Distribution Test	
Coefficient of Variation	4.70798575	A-D Test Statistic	5.79391633
Skewness	5.95156846	A-D 5% Critical Value	0.9011348
		K-S Test Statistic	0.2930231
		K-S 5% Critical Value	0.15430811
Gamma Statistics			
k hat	0.2037546	Data do not follow gamma distribution	
k star (bias corrected)	0.20513967	at 5% significance level	
Theta hat	30045.3959		
Theta star	29842.534	95% UCLs (Assuming Gamma Distribution)	
nu hat	16.3003677	Approximate Gamma UCL	12175.2709
nu star	16.4111734	Adjusted Gamma UCL	12504.6428
Approx.Chi Square Value (.05)	8.2517554		
Adjusted Level of Significance	0.044	Lognormal Distribution Test	
Adjusted Chi Square Value	8.03440445	Shapiro-Wilk Test Statistic	0.85262189
		Shapiro-Wilk 5% Critical Value	0.94
		Data not lognormal at 5% significance level	
Log-transformed Statistics			
Minimum of log data	2.94443898		
Maximum of log data	12.1007121	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	5.11830816	95% H-UCL	12963.1721
Standard Deviation of log data	2.35271263	95% Chebyshev (MVUE) UCL	7181.21229
Variance of log data	5.53525673	97.5% Chebyshev (MVUE) UCL	9367.21935
		99% Chebyshev (MVUE) UCL	13661.2069
95% Non-parametric UCLs			
		CLT UCL	13617.6833
		Adj-CLT UCL (Adjusted for skewness)	18199.8653
		Mod-t UCL (Adjusted for skewness)	14514.7923
		Jackknife UCL	13800.0645
		Standard Bootstrap UCL	13467.0236
		Bootstrap-t UCL	114615.385
		Hall's Bootstrap UCL	77530.7422
		Percentile Bootstrap UCL	14544.8125
		BCA Bootstrap UCL	20389.975
		95% Chebyshev (Mean, Sd) UCL	25985.9141
		97.5% Chebyshev (Mean, Sd) UCL	34581.0943
		99% Cheb	51464.6614
RECOMMENDATION			
Data are Non-parametric (0.05)			
Use 99% Chebyshev (Mean, Sd) UCL			
All units are in micrograms/kilogram ($\mu\text{g/kg}$)			

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface Soils (0-1 foot)
Lead (0-1)

Raw Statistics			
Number of Valid Samples	12	Shapiro-Wilk Test Statistic	0.611513
Number of Unique Samples	12	Shapiro-Wilk 5% Critical Value	0.859
Minimum	2.8	Data not normal at 5% significance level	
Maximum	440		
Mean	83.4	95% UCL (Assuming Normal Distribution)	
Median	37	Student's-t UCL	145.41087
Standard Deviation	119.61344		
Variance	14307.375	Gamma Distribution Test	
Coefficient of Variation	1.4342139	A-D Test Statistic	0.6366391
Skewness	2.811318	A-D 5% Critical Value	0.7605823
		K-S Test Statistic	0.2294362
		K-S 5% Critical Value	0.2534168
Gamma Statistics			
k hat	0.8915822	Data follow gamma distribution	
k star (bias corrected)	0.7242422	at 5% significance level	
Theta hat	93.541575		
Theta star	115.15485	95% UCLs (Assuming Gamma Distribution)	
nu hat	21.397972	Approximate Gamma UCL	162.07457
nu star	17.381812	Adjusted Gamma UCL	180.39415
Approx.Chi Square Value (.05)	8.9442971		
Adjusted Level of Significance	0.02896	Lognormal Distribution Test	
Adjusted Chi Square Value	8.0359767	Shapiro-Wilk Test Statistic	0.9332538
		Shapiro-Wilk 5% Critical Value	0.859
		Data are lognormal at 5% significance level	
Log-transformed Statistics			
Minimum of log data	1.0296194		
Maximum of log data	6.0867747	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	3.767181	95% H-UCL	323.07554
Standard Deviation of log data	1.2340628	95% Chebyshev (MVUE) UCL	225.83094
Variance of log data	1.5229111	97.5% Chebyshev (MVUE) UCL	287.16819
		99% Chebyshev (MVUE) UCL	407.65335
95% Non-parametric UCLs			
		CLT UCL	140.19585
		Adj-CLT UCL (Adjusted for skewness)	170.13842
		Mod-t UCL (Adjusted for skewness)	150.0813
		Jackknife UCL	145.41087
		Standard Bootstrap UCL	138.48303
		Bootstrap-t UCL	269.8494
		Hall's Bootstrap UCL	350.05716
		Percentile Bootstrap UCL	137.15
		BCA Bootstrap UCL	180.16667
RECOMMENDATION		95% Chebyshev (Mean, Sd) UCL	233.91028
Data follow gamma distribution (0.05)		97.5% Chebyshev (Mean, Sd) UCL	299.03619
Use Approximate Gamma UCL		99% Chebyshev (Mean, Sd) UCL	426.96344
All units are in milligrams/kilogram (mg/kg)			

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface Soils (0-1 foot)
Benzo(a)pyrene (0-1)

Raw Statistics			
Number of Valid Samples	12	Shapiro-Wilk Test Statistic	0.8330616
Number of Unique Samples	7	Shapiro-Wilk 5% Critical Value	0.859
Minimum	17	Data not normal at 5% significance level	
Maximum	390		
Mean	138	95% UCL (Assuming Normal Distribution)	
Median	140	Student's-t UCL	187.99336
Standard Deviation	96.432737		
Variance	9299.2727	Gamma Distribution Test	
Coefficient of Variation	0.6987879	A-D Test Statistic	0.5371884
Skewness	1.5566246	A-D 5% Critical Value	0.7412502
		K-S Test Statistic	0.2107995
		K-S 5% Critical Value	0.2484275
Gamma Statistics			
k hat	2.1074941	Data follow gamma distribution	
k star (bias corrected)	1.6361761	at 5% significance level	
Theta hat	65.480611		
Theta star	84.342999	95% UCLs (Assuming Gamma Distribution)	
nu hat	50.579858	Approximate Gamma UCL	209.13833
nu star	39.268227	Adjusted Gamma UCL	223.32449
Approx.Chi Square Value (.05)	25.911153		
Adjusted Level of Significance	0.02896	Lognormal Distribution Test	
Adjusted Chi Square Value	24.265208	Shapiro-Wilk Test Statistic	0.890894
		Shapiro-Wilk 5% Critical Value	0.859
		Data are lognormal at 5% significance level	
Log-transformed Statistics			
Minimum of log data	2.8332133		
Maximum of log data	5.9661467	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	4.6716278	95% H-UCL	289.98261
Standard Deviation of log data	0.8291598	95% Chebyshev (MVUE) UCL	305.32254
Variance of log data	0.687506	97.5% Chebyshev (MVUE) UCL	374.52066
		99% Chebyshev (MVUE) UCL	510.44696
95% Non-parametric UCLs			
		CLT UCL	183.789
		Adj-CLT UCL (Adjusted for skewness)	197.15518
		Mod-t UCL (Adjusted for skewness)	190.07821
		Jackknife UCL	187.99336
		Standard Bootstrap UCL	182.12898
		Bootstrap-t UCL	207.05152
		Hall's Bootstrap UCL	410.54355
		Percentile Bootstrap UCL	184.5
		BCA Bootstrap UCL	197.08333
		95% Chebyshev (Mean, Sd) UCL	259.34187
		97.5% Chebyshev (Mean, Sd) UCL	311.84659
		99% Chebyshev (Mean, Sd) UCL	414.98195
RECOMMENDATION			
Data follow gamma distribution (0.05)			
Use Approximate Gamma UCL			
All units are in micrograms/kilogram (mg/kg)			

Attachment F2
ProUCL Summary Tables
Residential Receptor Exposed to Surface Soils (0-1 foot)
Arsenic (0-1)

Raw Statistics			
Number of Valid Samples	12	Shapiro-Wilk Test Statistic	0.7516129
Number of Unique Samples	12	Shapiro-Wilk 5% Critical Value	0.859
Minimum	0.55	Data not normal at 5% significance level	
Maximum	8.5		
Mean	2.7541667	95% UCL (Assuming Normal Distribution)	
Median	2.35	Student's-t UCL	3.7948703
Standard Deviation	2.0074247		
Variance	4.0297538	Gamma Distribution Test	
Coefficient of Variation	0.7288683	A-D Test Statistic	0.4334293
Skewness	2.3513053	A-D 5% Critical Value	0.7396497
		K-S Test Statistic	0.1704712
		K-S 5% Critical Value	0.2477006
Gamma Statistics			
k hat	2.7451198	Data follow gamma distribution	
k star (bias corrected)	2.1143954	at 5% significance level	
Theta hat	1.0032956		
Theta star	1.3025788	95% UCLs (Assuming Gamma Distribution)	
nu hat	65.882874	Approximate Gamma UCL	3.9498227
nu star	50.745489	Adjusted Gamma UCL	4.1800819
Approx.Chi Square Value (.05)	35.384255		
Adjusted Level of Significance	0.02896	Lognormal Distribution Test	
Adjusted Chi Square Value	33.435119	Shapiro-Wilk Test Statistic	0.9454435
		Shapiro-Wilk 5% Critical Value	0.859
Log-transformed Statistics			
Minimum of log data	-0.597837	Data are lognormal at 5% significance level	
Maximum of log data	2.1400662	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	0.8200535	95% H-UCL	4.4519252
Standard Deviation of log data	0.6519918	95% Chebyshev (MVUE) UCL	5.0928155
Variance of log data	0.4250933	97.5% Chebyshev (MVUE) UCL	6.1060015
		99% Chebyshev (MVUE) UCL	8.0962093
95% Non-parametric UCLs			
		CLT UCL	3.7073488
		Adj-CLT UCL (Adjusted for skewness)	4.1276372
		Mod-t UCL (Adjusted for skewness)	3.8604268
		Jackknife UCL	3.7948703
		Standard Bootstrap UCL	3.6681243
		Bootstrap-t UCL	4.6753064
		Hall's Bootstrap UCL	8.0444328
		Percentile Bootstrap UCL	3.7541667
		BCA Bootstrap UCL	4.2666667
		95% Chebyshev (Mean, Sd) UCL	5.2801206
		97.5% Chebyshev (Mean, Sd) UCL	6.3731029
		99% Chebyshev (Mean, Sd) UCL	8.520055
RECOMMENDATION			
Data follow gamma distribution (0.05)			
Use Approximate Gamma UCL			
All units are in milligrams/kilogram (mg/kg)			

ATTACHMENT F3

Risk Calculations

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Attachment F

Table 1a
Risk Calculations: Reasonable Maximum Exposure
Residential Adult and Child: Incidental Ingestion of Soil Pathway (0-1 feet) – Carcinogenic Effects

$$\text{Ing-Risk} = \frac{(\text{Csoil} \times \text{SFo} \times \text{CF} \times \text{EF} \times \text{SIRadj} \times \text{FI})}{\text{ATc}}$$

Equation Units	Ing - Risk unitless	= (	Csoil mg/kg	×	SFo kg-day/mg	×	CF kg/mg	×	EF days/year	×	SIRadj mg-yr/kg-day	×	FI unitless	) ÷ (	ATc days)
Arsenic	3.50E-06	= (	3.67E+00	×	1.50E+00	×	1E-06	×	350	×	46.43	×	1	) ÷ (	25,550)
Lead	NA	= (	8.34E+01	×	a	×	1E-06	×	350	×	46.43	×	1	) ÷ (	25,550)
Benzo(a)pyrene	8.46E-07	= (	1.82E-01	×	7.30E+00	×	1E-06	×	350	×	46.43	×	1	) ÷ (	25,550)

Notes:

Ing - Risk – Ingestion risk

SIRadj – Age-adjusted Soil Ingestion Rate

Csoil – Soil Concentration

FI – Fraction Ingested from Contaminated Source

SFo – Oral Slope Factor

ATc – Averaging Time for Carcinogens

CF – Unit Conversion Factor

NV – No toxicity value available for this pathway.

EF – Exposure Frequency

NA – Not Applicable

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

Attachment F

Table 1b
Risk Calculations: Reasonable Maximum Exposure
Residential Adult and Child: Incidental Ingestion of Soil Pathway (0-1 feet) – Noncarcinogenic Effects

$$\text{Ing - HQ} = \frac{(C_{\text{soil}} \times CF \times EF \times ED_c \times SIR_c \times FI)}{(BW_c \times AT_n \times RfDo)}$$

Equation Units	Ing - HQ unitless	= (	C _{soil} mg/kg	×	CF kg/mg	×	EF days/year	×	ED _c years	×	SIR _c mg/day	×	FI unitless	) ÷ (	BW _c kg	×	AT _n days	×	RfDo ^(b) mg/kg-day
Arsenic	7.82E-02	= (	3.67E+00	×	1E-06	×	350	×	6	×	100	×	1	) ÷ (	15	×	2,190	×	3.0E-04
Lead	NA	= (	8.34E+01	×	1E-06	×	350	×	6	×	100	×	1	) ÷ (	15	×	2,190	×	a
Benzo(a)pyrene	NA	= (	1.82E-01	×	1E-06	×	350	×	6	×	100	×	1	) ÷ (	15	×	2,190	×	NV

Notes:

Ing - HQ – Ingestion Hazard

FI – Fraction Ingested from Contaminated Source

C_{soil} – Soil Concentration

BW_c – Body Weight, child

CF – Unit Conversion Factor

AT_n – Averaging Time for Noncarcinogens

EF – Exposure Frequency

RfDo – Oral reference dose (subchronic)

ED_c – Exposure Duration, child

NV – No toxicity value available for this pathway.

SIR_c – Soil Ingestion Rate, child

NA – Not Applicable

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

b – Subchronic toxicity values were used for each individual chemical, chronic toxicity values were used if subchronic values were not available.

Attachment F

Table 2a
Risk Calculations: Reasonable Maximum Exposure
Residential Adult and Child: Dermal Contact with Soil Pathway (0-1 feet) – Carcinogenic Effects

$\text{Derm - Risk} = \frac{(\text{Csoil} \times \text{SFabs} \times \text{CF} \times \text{EF} \times \text{EV} \times \text{SCRadj} \times \text{ABSd})}{\text{ATc}}$												
Equation Units	Derm - Risk unitless	Csoil mg/kg	SFabs kg-day/mg	CF kg/mg	EF days/year	EV events/day	SCRadj mg-yr/kg-event	ABSd unitless	) ÷ (	ATc days		
Arsenic	1.24E-07	= (3.67E+00 × 1.58E+00 × 1E-06 × 350 × 1 × 52 × 3.00E-02) ÷ (25,550)										
Lead	NA	= (8.34E+01 × a × 1E-06 × 350 × 1 × 52 × NA) ÷ (25,550)										
Benzo(a)pyrene	1.23E-07	= (1.82E-01 × 7.30E+00 × 1E-06 × 350 × 1 × 52 × 1.30E-01) ÷ (25,550)										

Notes:

Derm - Risk – Dermal Risk

Csoil – Soil Concentration

SFabs – Absorbed slope factor (SFo ÷ ABSgi)

CF – Unit Conversion Factor

EF – Exposure Frequency

EV – Event Frequency

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

SCRadj – Age-adjusted Soil Contact Rate

ABSd – Dermal Soil Absorption Factor

ATc – Averaging Time for Carcinogens

NA – Not Applicable

NV – No toxicity value available for this pathway.

Attachment F

Table 2b
Risk Calculations: Reasonable Maximum Exposure
Residential Adult and Child: Dermal Contact with Soil Pathway (0-1 feet) – Noncarcinogenic Effects

$$\text{Derm - HQ} = \frac{(C_{\text{soil}} \times CF \times EF \times ED_c \times EV \times SA_c \times AF_c \times ABS_d)}{(BW_c \times AT_n \times RfD_{\text{abs}})}$$

Equation Units	Derm - HQ	=	(	C _{soil}	×	CF	×	EF	×	ED _c	×	EV	×	S _A c	×	AF _c	×	AB _S d	)	÷	(	BW _c	×	AT _n	×	RfD _{abs} ^(b))
	unitless			mg/kg		kg/mg		days/year		years		events/day		cm ²		mg/cm ² -event		unitless			kg		days		mg/kg-day		
Arsenic	2.76E-03	=	(	3.67E+00	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.04	×	3.00E-02	)	÷	(	15	×	2,190	×	2.85E-04)
Lead	NA	=	(	8.34E+01	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.04	×	NA	)	÷	(	15	×	2,190	×	a)
Benzo(a)pyrene	NA	=	(	1.82E-01	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.04	×	1.30E-01	)	÷	(	15	×	2,190	×	NV)

Notes:

Derm - HQ – Dermal Hazard Quotient

AF_c – Soil-to-skin Adherence Factor, child

C_{soil} – Soil Concentration

AB_Sd – Dermal Soil Absorption Factor

CF – Unit Conversion Factor

BW_c – Body Weight, child

EF – Exposure Frequency

AT_n – Averaging Time for noncarcinogens

ED_c – Exposure Duration, child

RfD_{abs} – Absorbed reference dose (RfDo × AB_Sgi)

EV – Event Frequency

NA – Not Applicable

SA_c – Skin Surface Area, child

NV – No toxicity value available for this pathway.

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

b – Subchronic toxicity values were used for each individual chemical, chronic toxicity values were used if subchronic values were not available.

Attachment F

Table 3a
Risk Calculations: Reasonable Maximum Exposure
Residential Adult and Child: Inhalation of Soil-derived Chemicals Pathway (0-1 feet) – Carcinogenic Effects

$$\text{Inh - Risk} = \frac{(\text{Csoil} \times \text{SFI} \times \text{EF} \times \text{SInhRadj} \times [(1/\text{VF}) + (1/\text{PEF})])}{\text{ATc}}$$

Equation Units	Inh - Risk unitless	= (	Csoil mg/kg	×	SFI kg-day/mg	×	EF days/year	×	SInhRadj m3-yr/kg-day	× [1 /	VF _{adult} m ³ /kg	+ 1 /	PEF m ³ /kg	] ) ÷ (	ATc days
Arsenic	5.27E-10	= (	3.67E+00	×	1.51E+01	×	350	×	4.58	×	[1 /	NA	+ 1 /	6.58E+09	] ) ÷ ( 25,550)
Lead	NA	= (	8.34E+01	×	a	×	350	×	4.58	×	[1 /	NA	+ 1 /	6.58E+09	] ) ÷ ( 25,550)
Benzo(a)pyrene	5.35E-12	= (	1.82E-01	×	3.08E+00	×	350	×	4.58	×	[1 /	NC	+ 1 /	6.58E+09	] ) ÷ ( 25,550)

Notes:

Inh - Risk – Inhalation Risk

Csoil – Soil Concentration

SFI – Inhalation Slope Factor

EF – Exposure frequency

SInhRadj – Age-adjusted Soil Inhalation Rate

VF – Volatilization Factor

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

PEF – Particulate Emission Factor

BW – Body Weight

ATc – Averaging Time for Carcinogens

NV – No toxicity value available for this pathway.

NA – Not Applicable

NC – Not Calculated

Attachment F

Table 3b
Risk Calculations: Reasonable Maximum Exposure
Residential Adult and Child: Inhalation of Soil-derived Chemicals Pathway (0-1 feet) – Noncarcinogenic Effects

$$\text{Inh - HQ} = \frac{(\text{Csoil} \times \text{InhRc} \times \text{EF} \times \text{EDc} \times ([1/\text{VF}] + [1/\text{PEF}]))}{(\text{BWc} \times \text{ATn} \times \text{RfDi})}$$

Equation Units	Inh - HQ unitless	= (	Csoil mg/kg	×	InhRc m³/day	×	EF days/year	×	EDc year	×	[1 / VF _{child} m³/kg]	+ 1 / PEF m³/kg ]	÷ (	BWc kg	×	ATn days	×	RfDi (b) mg/kg-day)
Arsenic	NA	= (	3.67E+00	×	7.2	×	350	×	6	×	[1 / NA]	+ 1 / 6.58E+09 ]	÷ (	15	×	2,190	×	NV)
Lead	NA	= (	8.34E+01	×	7.2	×	350	×	6	×	[1 / NA]	+ 1 / 6.58E+09 ]	÷ (	15	×	2,190	×	a)
Benzo(a)pyrene	NA	= (	1.82E-01	×	7.2	×	350	×	6	×	[1 / NC]	+ 1 / 6.58E+09 ]	÷ (	15	×	2,190	×	NV)

Notes:

Inh - Risk – Inhalation Hazard Quotient

PEF – Particulate Emission Factor

Csoil – Soil Concentration

BWc – Body Weight, child

InhRc – Inhalation Rate, child

ATn – Averaging Time for Noncarcinogens

EF – Exposure frequency

RfDi – Inhalation Reference Dose (subchronic)

EDc – Exposure duration, child

NV – No toxicity value available for this pathway.

VF – Volatilization Factor

NA – Not Applicable

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

b – Subchronic toxicity values were used for each individual chemical, chronic toxicity values were used if subchronic values were not available.

Attachment F

Table 3c
Residential Scenario: Volatilization Factor Calculations

Equation:

$$VF = \frac{Q}{C_{VF}} \times \frac{(3.14 \times D_A \times T)^{1/2}}{2 \times \rho_b \times D_A} \times 10^{-4} \frac{m^2}{cm^2}$$

Chemical	Q/C _{VF} (g/m ² -s)/(kg/m ³)	π	D _A (cm ² /s)	T _{adult} (s)	T _{child} (s)	2	ρ _b (g/cm ³)	10 ⁻⁴ (m ² /cm ²)	VF _{adult} (m ³ /kg)	VF _{child} (m ³ /kg)
Benzo(a)pyrene	73.32	3.14	NC	9.46E+08	1.89E+08	2	1.38	1.00E-04	NC	NC

Notes:

Default values are as presented in Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA 2002).

VF_{adult} – Volatilization Factor (m³/kg) for adults (calculated)

VF_{child} – Volatilization Factor (m³/kg) for children (calculated)

Q/C_{VF} – Inverse of mean concentration at the center of 1 acre square source
(g/m²-s)/(kg/m³)(Value used is for Minneapolis, MN.)

π – pi (3.14)

D_A – Apparent Diffusivity (cm²/s)

T_{adult} – Exposure interval (s) for adults

T_{child} – Exposure interval (s) for children

ρ_b – Dry soil bulk density (g/cm³) (site-specific value)

NC – Not calculated; PAHs are not considered volatile chemicals

Attachment F

Table 3d
Residential Scenario: Apparent Diffusivity Calculations

Equation:

$$D_A = \frac{(\theta_a^{3.33} \times D_i \times H') + (\theta_w^{3.33} \times D_w)}{\eta^2} \times \frac{1}{(\rho_b \times K_d) + \theta_w + (\theta_a \times H')},$$

Chemical Units	VOC?	θ_a (Lair /Lsoil)	D_i (cm ² /s)	H' unitless	θ_w (Lwater /Lsoil)	D_w (cm ² /s)	η (Lpore /Lsoil)	ρ_b (g/cm ³)	ρ_s (g/cm ³)	K_d (cm ³ /g)	D_A (cm ² /s)
Benzo(a)pyrene	No	3.29E-01	4.30E-02	4.63E-05	0.15	9.00E-06	4.79E-01	1.38	2.65	4.72E+03	NC

Notes:

D_A – apparent diffusivity

K_d – soil-water partition coefficient, where:

θ_a – air-filled soil porosity

$K_d = Koc \times foc$

D_i – diffusivity in air

Koc – soil organic carbon partition coefficient (cm³/g)

H' – dimensionless Henry's Law constant

foc – fraction organic carbon in soil (g/g) (A default value of 0.006 g/g was used.)

θ_w – water-filled soil porosity

VOC? – Volatile organic compounds; If no, an apparent diffusivity was not calculated.

D_w – diffusivity in water

NV – no value available

η – total soil porosity

NC – not calculated

ρ_b – dry soil bulk density based on soil type of silty clay. Value obtained from *User'S Guide For Evaluating Subsurface Vapor Intrusion Into Buildings* (USEPA, 2003).

ρ_s – soil particle density

Attachment F

Table 3e
Residential Scenario: Particulation Emission Factor Calculations

$$PEF = Q/C \times \frac{3600 \text{ s/h}}{0.036 \times (1 - V) \times (U_m/U_t)^3 \times F(x)}$$

PEF – Particulate emission factor

Q/C – Inverse of mean concentration at center of a 0.5-acre-square source (see calculation presented below)

V – Fraction of vegetative cover. It is assumed that 10% of the surface cover at residential properties are bare (garden beds)

Um – Mean annual windspeed

Ut – Equivalent threshold value of windspeed at 7 m

F(x) – Function dependent on UmUt derived using Cowherd

Equation Units	PEF m³/kg	=	Q/C g/m²-s per kg/m³	× [3600 ÷ (0.036	×	(1	-	V)	×	(Um m/s	/	Ut m/s) ³	×	F(x) unitless)
All Chemicals	6.58E+09	=	90.8	×	[3600 ÷ 0.036	×	(1	-	0.9)	×	[4.69 / 11.32) ³	×	0.194)					

Default values are as presented in Soil Screening Technical Background Document (USEPA 1996).

Attachment F

Table 4a
Risk Calculations: Reasonable Maximum Exposure
Residential Adult and Child: Incidental Ingestion of Soil Pathway (0-3 feet) – Carcinogenic Effects

$$\text{Ing-Risk} = \frac{(\text{Csoil} \times \text{SFo} \times \text{CF} \times \text{EF} \times \text{SIRadj} \times \text{FI})}{\text{ATc}}$$

Equation Units	Ing - Risk unitless	= (	Csoil mg/kg	×	SFo kg-day/mg	×	CF kg/mg	×	EF days/year	×	SIRadj mg-yr/kg-day	×	FI unitless	) ÷ (	ATc days)
Arsenic	8.78E-06	= (	3.74E+00	×	1.50E+00	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
Lead	NA	= (	1.76E+02	×	a	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
1-Methylnaphthalene	NA	= (	1.66E+01	×	NV	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
Benzo(a)anthracene	1.55E-05	= (	1.36E+01	×	7.30E-01	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
Benzo(a)pyrene	1.84E-04	= (	1.61E+01	×	7.30E+00	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
Benzo(b)fluoranthene	1.54E-05	= (	1.35E+01	×	7.30E-01	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
Benzo(k)fluoranthene	4.83E-07	= (	4.23E+00	×	7.30E-02	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
Dibenzo(a,h)anthracene	8.70E-06	= (	7.61E-01	×	7.30E+00	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
Fluoranthene	NA	= (	2.65E+01	×	NV	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
Indeno(1,2,3-cd)pyrene	3.88E-06	= (	3.39E+00	×	7.30E-01	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
Naphthalene	NA	= (	6.46E+00	×	NV	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
Pyrene	NA	= (	4.70E+01	×	NV	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
1,2,4-Trimethylbenzene	NA	= (	1.31E+00	×	NV	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
1,3,5-Trimethylbenzene	NA	= (	4.79E-01	×	NV	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)
Benzene	1.66E-07	= (	1.93E+00	×	5.50E-02	×	1E-06	×	350	×	114.28	×	1	) ÷ (	25,550)

Notes:

Ing - Risk – Ingestion risk

Csoil – Soil Concentration

SFo – Oral Slope Factor

CF – Unit Conversion Factor

EF – Exposure Frequency

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

SIRadj – Age-adjusted Soil Ingestion Rate

FI – Fraction Ingested from Contaminated Source

ATc – Averaging Time for Carcinogens

NV – No toxicity value available for this pathway.

NA – Not Applicable

Attachment F

Table 4b
Risk Calculations: Reasonable Maximum Exposure
Residential Child: Incidental Ingestion of Soil Pathway (0-3 feet) – Noncarcinogenic Effects

$$\text{Ing - HQ} = \frac{(\text{Csoil} \times \text{CF} \times \text{EF} \times \text{EDc} \times \text{SIRc} \times \text{FI})}{(\text{BWc} \times \text{ATn} \times \text{RfDo})}$$

Equation Units	Ing - HQ	= (	Csoil mg/kg	×	CF kg/mg	×	EF days/year	×	EDc years	×	SIRc mg/day	×	FI unitless	) ÷ (	BWc kg	×	ATn days	×	RfDo ^(b) mg/kg-day
Arsenic	1.59E-01	= (	3.74E+00	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	3.0E-04)
Lead	NA	= (	1.76E+02	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	a)
1-Methylnaphthalene	3.03E-03	= (	1.66E+01	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	7.0E-02)
Benzo(a)anthracene	NA	= (	1.36E+01	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	NV)
Benzo(a)pyrene	NA	= (	1.61E+01	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	NV)
Benzo(b)fluoranthene	NA	= (	1.35E+01	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	NV)
Benzo(k)fluoranthene	NA	= (	4.23E+00	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	NV)
Dibenzo(a,h)anthracene	NA	= (	7.61E-01	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	NV)
Fluoranthene	8.46E-04	= (	2.65E+01	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	4.0E-01)
Indeno(1,2,3-cd)pyrene	NA	= (	3.39E+00	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	NV)
Naphthalene	4.13E-03	= (	6.46E+00	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	2.0E-02)
Pyrene	2.00E-03	= (	4.70E+01	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	3.0E-01)
1,2,4-Trimethylbenzene	3.35E-04	= (	1.31E+00	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	5.0E-02)
1,3,5-Trimethylbenzene	1.23E-05	= (	4.79E-01	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	5.0E-01)
Benzene	6.17E-03	= (	1.93E+00	×	1E-06	×	350	×	6	×	200	×	1	) ÷ (	15	×	2,190	×	4.0E-03)

Notes:

Ing - HQ – Ingestion Hazard

Csoil – Soil Concentration

CF – Unit Conversion Factor

EF – Exposure Frequency

EDc – Exposure Duration, child

SIRc – Soil Ingestion Rate, child

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

b – Subchronic toxicity values were used for each individual chemical, chronic toxicity values were used if subchronic values were not available.

FI – Fraction Ingested from Contaminated Source

BWc – Body Weight, child

ATn – Averaging Time for Noncarcinogens

RfDo – Oral reference dose (subchronic)

NV – No toxicity value available for this pathway.

NA – Not Applicable

Attachment F

Table 5a
Risk Calculations: Reasonable Maximum Exposure
Residential Adult and Child: Dermal Contact with Soil Pathway (0-3 feet) – Carcinogenic Effects

$$\text{Derm - Risk} = \frac{(\text{Csoil} \times \text{SFabs} \times \text{CF} \times \text{EF} \times \text{EV} \times \text{SCRadj} \times \text{ABSd})}{\text{ATc}}$$

Equation Units	Derm - Risk unitless	Csoil mg/kg	×	SFabs kg-day/mg	×	CF kg/mg	×	EF days/year	×	EV events/day	×	SCRadj mg-yr/kg-event	×	ABSd unitless	) ÷ (	ATc days
Arsenic	8.74E-07	= (3.74E+00	×	1.58E+00	×	1E-06	×	350	×	1	×	360	×	3.00E-02	) ÷ (	25,550)
Lead	NA	= (1.76E+02	×	a	×	1E-06	×	350	×	1	×	360	×	NA	) ÷ (	25,550)
1-Methylnaphthalene	NA	= (1.66E+01	×	NV	×	1E-06	×	350	×	1	×	360	×	1.30E-01	) ÷ (	25,550)
Benzo(a)anthracene	6.36E-06	= (1.36E+01	×	7.30E-01	×	1E-06	×	350	×	1	×	360	×	1.30E-01	) ÷ (	25,550)
Benzo(a)pyrene	7.55E-05	= (1.61E+01	×	7.30E+00	×	1E-06	×	350	×	1	×	360	×	1.30E-01	) ÷ (	25,550)
Benzo(b)fluoranthene	6.31E-06	= (1.35E+01	×	7.30E-01	×	1E-06	×	350	×	1	×	360	×	1.30E-01	) ÷ (	25,550)
Benzo(k)fluoranthene	1.98E-07	= (4.23E+00	×	7.30E-02	×	1E-06	×	350	×	1	×	360	×	1.30E-01	) ÷ (	25,550)
Dibenzo(a,h)anthracene	3.57E-06	= (7.61E-01	×	7.30E+00	×	1E-06	×	350	×	1	×	360	×	1.30E-01	) ÷ (	25,550)
Fluoranthene	NA	= (2.65E+01	×	NV	×	1E-06	×	350	×	1	×	360	×	1.30E-01	) ÷ (	25,550)
Indeno(1,2,3-cd)pyrene	1.59E-06	= (3.39E+00	×	7.30E-01	×	1E-06	×	350	×	1	×	360	×	1.30E-01	) ÷ (	25,550)
Naphthalene	NA	= (6.46E+00	×	NV	×	1E-06	×	350	×	1	×	360	×	1.30E-01	) ÷ (	25,550)
Pyrene	NA	= (4.70E+01	×	NV	×	1E-06	×	350	×	1	×	360	×	1.30E-01	) ÷ (	25,550)
1,2,4-Trimethylbenzene	NA	= (1.31E+00	×	NV	×	1E-06	×	350	×	1	×	360	×	NA	) ÷ (	25,550)
1,3,5-Trimethylbenzene	NA	= (4.79E-01	×	NV	×	1E-06	×	350	×	1	×	360	×	NA	) ÷ (	25,550)
Benzene	NA	= (1.93E+00	×	5.50E-02	×	1E-06	×	350	×	1	×	360	×	NA	) ÷ (	25,550)

Notes:

Derm - Risk – Dermal Risk

Csoil – Soil Concentration

SFabs – Absorbed slope factor (SFo ÷ ABSgi)

CF – Unit Conversion Factor

EF – Exposure Frequency

EV – Event Frequency

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

SCRadj – Age-adjusted Soil Contact Rate

ABSd – Dermal Soil Absorption Factor

ATc – Averaging Time for Carcinogens

NA – Not Applicable

NV – No toxicity value available for this pathway.

Attachment F

Table 5b
Risk Calculations: Reasonable Maximum Exposure
Residential Child: Dermal Contact with Soil Pathway (0-3 feet) – Noncarcinogenic Effects

$$\text{Derm - HQ} = \frac{(\text{Csoil} \times \text{CF} \times \text{EF} \times \text{EDc} \times \text{EV} \times \text{SAc} \times \text{AFc} \times \text{ABSd})}{(\text{BWc} \times \text{ATn} \times \text{RfDabs})}$$

Equation Units	Derm - HQ unitless	= (	Csoil mg/kg	×	CF kg/mg	×	EF days/year	×	EDc years	×	EV events/day	×	SAc cm ²	×	AFc mg/cm ² -event	×	ABSd unitless	) ÷ (	BWc kg	×	ATn days	×	RfDabs ^(b) mg/kg-day
Arsenic	1.41E-02	= (	3.74E+00	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	3.00E-02	) ÷ (	15	×	2,190	×	2.85E-04)
Lead	NA	= (	1.76E+02	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	NA	) ÷ (	15	×	2,190	×	a)
1-Methylnaphthalene	1.10E-03	= (	1.66E+01	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	1.30E-01	) ÷ (	15	×	2,190	×	7.00E-02)
Benzo(a)anthracene	NA	= (	1.36E+01	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	1.30E-01	) ÷ (	15	×	2,190	×	NV)
Benzo(a)pyrene	NA	= (	1.61E+01	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	1.30E-01	) ÷ (	15	×	2,190	×	NV)
Benzo(b)fluoranthene	NA	= (	1.35E+01	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	1.30E-01	) ÷ (	15	×	2,190	×	NV)
Benzo(k)fluoranthene	NA	= (	4.23E+00	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	1.30E-01	) ÷ (	15	×	2,190	×	NV)
Dibenz(a,h)anthracene	NA	= (	7.61E-01	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	1.30E-01	) ÷ (	15	×	2,190	×	NV)
Fluoranthene	3.08E-04	= (	2.65E+01	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	1.30E-01	) ÷ (	15	×	2,190	×	4.00E-01)
Indeno(1,2,3-cd)pyrene	NA	= (	3.39E+00	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	1.30E-01	) ÷ (	15	×	2,190	×	NV)
Naphthalene	1.50E-03	= (	6.46E+00	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	1.30E-01	) ÷ (	15	×	2,190	×	2.00E-02)
Pyrene	7.29E-04	= (	4.70E+01	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	1.30E-01	) ÷ (	15	×	2,190	×	3.00E-01)
1,2,4-Trimethylbenzene	NA	= (	1.31E+00	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	NA	) ÷ (	15	×	2,190	×	5.00E-02)
1,3,5-Trimethylbenzene	NA	= (	4.79E-01	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	NA	) ÷ (	15	×	2,190	×	5.00E-01)
Benzene	NA	= (	1.93E+00	×	1E-06	×	350	×	6	×	1	×	2,800	×	0.2	×	NA	) ÷ (	15	×	2,190	×	4.00E-03)

Notes:

Derm - HQ – Dermal Hazard Quotient

Csoil – Soil Concentration

CF – Unit Conversion Factor

EF – Exposure Frequency

EDc – Exposure Duration, child

EV – Event Frequency

SAc – Skin Surface Area, child

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

b – Subchronic toxicity values were used for each individual chemical, chronic toxicity values were used if subchronic values were not available.

AFc – Soil-to-skin Adherence Factor, child

ABSd – Dermal Soil Absorption Factor

BWc – Body Weight, child

ATn – Averaging Time for noncarcinogens

RfDabs – Absorbed reference dose (RfDo × ABSgi)

NA – Not Applicable

NV – No toxicity value available for this pathway.

Attachment F

Table 6a
Risk Calculations: Reasonable Maximum Exposure
Residential Adult and Child: Inhalation of Soil-derived Chemicals Pathway (0-3 feet)– Carcinogenic Effects

$$\text{Inh - Risk} = \frac{(\text{Csoil} \times \text{SFI} \times \text{EF} \times \text{SinhRadj} \times [(1/\text{VF}) + (1/\text{PEF})])}{\text{ATc}}$$

Equation Units	Inh - Risk unitless	Csoil mg/kg	SFI kg-day/mg	EF days/year	SinhRadj m ³ -yr/kg-day	VF _{adult} m ³ /kg	1 /	PEF m ³ /kg	1 /	ATc days
Arsenic	1.27E-09	= (3.74E+00 × 1.51E+01 × 350 × 10.86 × [1 / NA + 1 / 6.58E+09]) ÷ (25,550)								
Lead	NA	= (1.76E+02 × a × 350 × 10.86 × [1 / NA + 1 / 6.58E+09]) ÷ (25,550)								
1-Methylnaphthalene	NA	= (1.66E+01 × NV × 350 × 10.86 × [1 / NC + 1 / 6.58E+09]) ÷ (25,550)								
Benzo(a)anthracene	NA	= (1.36E+01 × NV × 350 × 10.86 × [1 / NC + 1 / 6.58E+09]) ÷ (25,550)								
Benzo(a)pyrene	1.12E-09	= (1.61E+01 × 3.08E+00 × 350 × 10.86 × [1 / NC + 1 / 6.58E+09]) ÷ (25,550)								
Benzo(b)fluoranthene	NA	= (1.35E+01 × NV × 350 × 10.86 × [1 / NC + 1 / 6.58E+09]) ÷ (25,550)								
Benzo(k)fluoranthene	NA	= (4.23E+00 × NV × 350 × 10.86 × [1 / NC + 1 / 6.58E+09]) ÷ (25,550)								
Dibenz(a,h)anthracene	NA	= (7.61E-01 × NV × 350 × 10.86 × [1 / NC + 1 / 6.58E+09]) ÷ (25,550)								
Fluoranthene	NA	= (2.65E+01 × NV × 350 × 10.86 × [1 / NC + 1 / 6.58E+09]) ÷ (25,550)								
Indeno(1,2,3-cd)pyrene	NA	= (3.39E+00 × NV × 350 × 10.86 × [1 / NC + 1 / 6.58E+09]) ÷ (25,550)								
Naphthalene	NA	= (6.46E+00 × NV × 350 × 10.86 × [1 / 2.87E+04 + 1 / 6.58E+09]) ÷ (25,550)								
Pyrene	NA	= (4.70E+01 × NV × 350 × 10.86 × [1 / 3.05E+05 + 1 / 6.58E+09]) ÷ (25,550)								
1,2,4-Trimethylbenzene	NA	= (1.31E+00 × NV × 350 × 10.86 × [1 / 5.47E+03 + 1 / 6.58E+09]) ÷ (25,550)								
1,3,5-Trimethylbenzene	NA	= (4.79E-01 × NV × 350 × 10.86 × [1 / 4.52E+03 + 1 / 6.58E+09]) ÷ (25,550)								
Benzene	2.45E-06	= (1.93E+00 × 2.73E-02 × 350 × 10.86 × [1 / 3.20E+03 + 1 / 6.58E+09]) ÷ (25,550)								

Notes:

Inh - Risk – Inhalation Risk

Csoil – Soil Concentration

SFI – Inhalation Slope Factor

EF – Exposure frequency

SinhRadj – Age-adjusted Soil Inhalation Rate

VF – Volatilization Factor

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

PEF – Particulate Emission Factor

BW – Body Weight

ATc – Averaging Time for Carcinogens

NV – No toxicity value available for this pathway.

NA – Not Applicable

NC – Not Calculated

Attachment F

Table 6b
Risk Calculations: Reasonable Maximum Exposure
Residential Child: Inhalation of Soil-derived Pathway (0-3 feet) – Noncarcinogenic Effects

$$\text{Inh - HQ} = \frac{(\text{Csoil} \times \text{InhRc} \times \text{EF} \times \text{EDc} \times ([1/\text{VF}] + [1/\text{PEF}]))}{(\text{BWc} \times \text{ATn} \times \text{RfDi})}$$

Equation Units	Inh - HQ unitless	= (	Csoil mg/kg	×	InhRc m³/day	×	EF days/year	×	EDc year	×	[1 /	VF _{child} m³/kg	+ 1 /	PEF m³/kg	]	÷ (	BWc kg	×	ATn days	×	RfDi (b) mg/kg-day)
Arsenic	NA	= (	3.74E+00	×	10	×	350	×	6	×	[1 /	NA	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	NV)
Lead	NA	= (	1.76E+02	×	10	×	350	×	6	×	[1 /	NA	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	a)
1-Methylnaphthalene	NA	= (	1.66E+01	×	10	×	350	×	6	×	[1 /	1.47E+04	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	NV)
Benzo(a)anthracene	NA	= (	1.36E+01	×	10	×	350	×	6	×	[1 /	NC	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	NV)
Benzo(a)pyrene	NA	= (	1.61E+01	×	10	×	350	×	6	×	[1 /	NC	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	NV)
Benzo(b)fluoranthene	NA	= (	1.35E+01	×	10	×	350	×	6	×	[1 /	NC	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	NV)
Benzo(k)fluoranthene	NA	= (	4.23E+00	×	10	×	350	×	6	×	[1 /	NC	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	NV)
Dibenz(a,h)anthracene	NA	= (	7.61E-01	×	10	×	350	×	6	×	[1 /	NC	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	NV)
Fluoranthene	NA	= (	2.65E+01	×	10	×	350	×	6	×	[1 /	NC	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	NV)
Indeno(1,2,3-cd)pyrene	NA	= (	3.39E+00	×	10	×	350	×	6	×	[1 /	NC	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	NV)
Naphthalene	3.75E-01	= (	6.46E+00	×	10	×	350	×	6	×	[1 /	1.29E+04	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	8.57E-04)
Pyrene	NA	= (	4.70E+01	×	10	×	350	×	6	×	[1 /	1.36E+05	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	NV)
1,2,4-Trimethylbenzene	2.00E-01	= (	1.31E+00	×	10	×	350	×	6	×	[1 /	2.44E+03	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	1.71E-03)
1,3,5-Trimethylbenzene	8.91E-03	= (	4.79E-01	×	10	×	350	×	6	×	[1 /	2.02E+03	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	1.70E-02)
Benzene	1.01E-01	= (	1.93E+00	×	10	×	350	×	6	×	[1 /	1.43E+03	+ 1 /	6.58E+09	]	÷ (	15	×	2,190	×	8.57E-03)

Notes:

Inh - Risk – Inhalation Hazard Quotient

PEF – Particulate Emission Factor

Csoil – Soil Concentration

BWc – Body Weight, child

InhRc – Inhalation Rate, child

ATn – Averaging Time for Noncarcinogens

EF – Exposure frequency

RfDi – Inhalation Reference Dose (subchronic)

EDc – Exposure duration, child

NV – No toxicity value available for this pathway.

VF – Volatilization Factor

NA – Not Applicable

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

b – Subchronic toxicity values were used for each individual chemical, chronic toxicity values were used if subchronic values were not available.

Attachment F

Table 6c
Residential Scenario: Volatilization Factor Calculations

Equation:

$$VF = \frac{Q}{C_{VF}} \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} \frac{m^2}{cm^2}$$

Chemical	Q/C _{VF} (g/m ² ·s)/(kg/m ³)	π	D _A (cm ² /s)	T _{adult} (s)	T _{child} (s)	2	ρ _b (g/cm ³)	10 ⁻⁴ (m ² /cm ²)	VF _{adult} (m ³ /kg)	VF _{child} (m ³ /kg)
1-Methylnaphthalene	73.32	3.14	1.95E-05	9.46E+08	1.89E+08	2	1.38	1.00E-04	3.28E+04	1.47E+04
Benzo(a)anthracene	73.32	3.14	NC	9.46E+08	1.89E+08	2	1.38	1.00E-04	NC	NC
Benzo(a)pyrene	73.32	3.14	NC	9.46E+08	1.89E+08	2	1.38	1.00E-04	NC	NC
Benzo(b)fluoranthene	73.32	3.14	NC	9.46E+08	1.89E+08	2	1.38	1.00E-04	NC	NC
Benzo(k)fluoranthene	73.32	3.14	NC	9.46E+08	1.89E+08	2	1.38	1.00E-04	NC	NC
Dibenzo(a,h)anthracene	73.32	3.14	NC	9.46E+08	1.89E+08	2	1.38	1.00E-04	NC	NC
Fluoranthene	73.32	3.14	NC	9.46E+08	1.89E+08	2	1.38	1.00E-04	NC	NC
Indeno(1,2,3-cd)pyrene	73.32	3.14	NC	9.46E+08	1.89E+08	2	1.38	1.00E-04	NC	NC
Naphthalene	73.32	3.14	2.54E-05	9.46E+08	1.89E+08	2	1.38	1.00E-04	2.87E+04	1.29E+04
Pyrene	73.32	3.14	2.25E-07	9.46E+08	1.89E+08	2	1.38	1.00E-04	3.05E+05	1.36E+05
1,2,4-Trimethylbenzene	73.32	3.14	7.01E-04	9.46E+08	1.89E+08	2	1.38	1.00E-04	5.47E+03	2.44E+03
1,3,5-Trimethylbenzene	73.32	3.14	1.02E-03	9.46E+08	1.89E+08	2	1.38	1.00E-04	4.52E+03	2.02E+03
Benzene	73.32	3.14	2.05E-03	9.46E+08	1.89E+08	2	1.38	1.00E-04	3.20E+03	1.43E+03

Notes:

Default values are as presented in Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA 2002).

VF_{adult} – Volatilization Factor (m³/kg) for adults (calculated)

VF_{child} – Volatilization Factor (m³/kg) for children (calculated)

Q/C_{VF} – Inverse of mean concentration at the center of 1 acre square source

(g/m²·s)/(kg/m³) (Value used is for Minneapolis, MN.)

π – pi (3.14)

D_A – Apparent Diffusivity (cm²/s)

T_{adult} – Exposure interval (s) for adults

T_{child} – Exposure interval (s) for children

ρ_b – Dry soil bulk density (g/cm³) (site-specific value)

NC – Not calculated; PAHs are not considered volatile chemicals

Attachment F

Table 6d
Residential Scenario: Apparent Diffusivity Calculations

Equation:

$$D_A = \frac{(\theta_a^{3.33} \times D_i \times H') + (\theta_w^{3.33} \times D_w)}{\eta^2} \times \frac{1}{(\rho_b \times K_d) + \theta_w + (\theta_a \times H')}$$

Chemical Units	VOC?	θ_a (Lair /Lsoil)	D_i (cm ² /s)	H' unitless	θ_w (Lwater /Lsoil)	D_w (cm ² /s)	η (Lpore /Lsoil)	ρ_b (g/cm ³)	ρ_s (g/cm ³)	K_d (cm ³ /g)	D_A (cm ² /s)
1-Methylnaphthalene	Yes	3.29E-01	6.31E-02	1.64E-02	0.15	7.13E-06	4.79E-01	1.38	2.65	3.75E+01	1.95E-05
Benzo(a)anthracene	No	3.29E-01	5.10E-02	4.91E-04	0.15	9.00E-06	4.79E-01	1.38	2.65	1.39E+03	NC
Benzo(a)pyrene	No	3.29E-01	4.30E-02	4.63E-05	0.15	9.00E-06	4.79E-01	1.38	2.65	4.72E+03	NC
Benzo(b)fluoranthene	No	3.29E-01	2.26E-02	2.69E-05	0.15	5.56E-06	4.79E-01	1.38	2.65	4.82E+03	NC
Benzo(k)fluoranthene	No	3.29E-01	2.26E-02	2.39E-05	0.15	5.56E-06	4.79E-01	1.38	2.65	4.72E+03	NC
Dibeno(a,h)anthracene	No	3.29E-01	2.02E-02	5.03E-06	0.15	5.18E-06	4.79E-01	1.38	2.65	1.57E+04	NC
Fluoranthene	No	3.29E-01	3.02E-02	3.62E-04	0.15	6.35E-06	4.79E-01	1.38	2.65	4.25E+02	NC
Indeno(1,2,3-cd)pyrene	No	3.29E-01	1.90E-02	1.42E-05	0.15	5.66E-06	4.79E-01	1.38	2.65	1.61E+04	NC
Naphthalene	Yes	3.29E-01	5.90E-02	1.80E-02	0.15	7.50E-06	4.79E-01	1.38	2.65	1.10E+01	2.54E-05
Pyrene	Yes	3.29E-01	2.72E-02	4.87E-04	0.15	7.24E-06	4.79E-01	1.38	2.65	4.16E+02	2.25E-07
1,2,4-Trimethylbenzene	Yes	3.29E-01	6.44E-02	2.52E-01	0.15	7.92E-06	4.79E-01	1.38	2.65	4.31E+00	7.01E-04
1,3,5-Trimethylbenzene	Yes	3.29E-01	6.02E-02	3.59E-01	0.15	8.67E-06	4.79E-01	1.38	2.65	4.22E+00	1.02E-03
Benzene	Yes	3.29E-01	8.80E-02	2.27E-01	0.15	9.80E-06	4.79E-01	1.38	2.65	9.93E-01	2.05E-03

Notes:

D_A – apparent diffusivity

K_d – soil-water partition coefficient, where:

$$K_d = Koc \times foc$$

θ_a – air-filled soil porosity

Koc – soil organic carbon partition coefficient (cm³/g)

D_i – diffusivity in air

foc – fraction organic carbon in soil (g/g) (A default value of 0.006 g/g was used.)

H' – dimensionless Henry's Law constant

VOC? – Volatile organic compounds; If no, an apparent diffusivity was not calculated.

θ_w – water-filled soil porosity

NV – no value available

D_w – diffusivity in water

NC – not calculated

η – total soil porosity

ρ_b – dry soil bulk density based on soil type of silty clay. Value obtained from *User'S Guide For Evaluating Subsurface Vapor Intrusion Into Buildings* (USEPA, 2003).

ρ_s – soil particle density

Attachment F

Table 7a
Risk Calculations: Reasonable Maximum Exposure
Construction Worker: Incidental Ingestion of Soil Pathway – Carcinogenic Effects (0-4 feet)

$$\text{Ing-Risk} = \frac{(C_{\text{soil}} \times SF_{\text{o}} \times CF \times EF \times ED \times SIR \times FI)}{(BW \times ATc)}$$

Equation Units	Ing - Risk unitless	C_{soil} mg/kg	SF_{o} kg-day/mg	CF kg/mg	EF days/year	ED years	SIR mg/day	FI unitless	\div	BW kg	ATc days
Inorganics											
Arsenic	$3.05E-07$	= (4.40E+00 \times 1.50E+00 \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Lead	NA	= (1.00E+02 \times a \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Vanadium	NA	= (3.12E+01 \times NV \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
SVOCs											
2-Methylnaphthalene	NA	= (1.88E+03 \times NV \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Acenaphthene	NA	= (3.38E+02 \times NV \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Acenaphthylene	NA	= (5.50E+02 \times NV \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Benzo(a)anthracene	$6.74E-06$	= (2.00E+02 \times 7.30E-01 \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Benzo(a)pyrene	$4.96E-05$	= (1.47E+02 \times 7.30E+00 \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Benzo(b)fluoranthene	$3.08E-06$	= (9.15E+01 \times 7.30E-01 \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Benzo(k)fluoranthene	$3.77E-07$	= (1.12E+02 \times 7.30E-02 \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Chrysene	$5.91E-08$	= (1.75E+02 \times 7.30E-03 \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Dibeno(a,h)anthracene	$7.22E-06$	= (2.14E+01 \times 7.30E+00 \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Dibenzo furan	NA	= (1.11E+02 \times NV \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Fluoranthene	NA	= (3.18E+02 \times NV \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Fluorene	NA	= (3.06E+02 \times NV \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Indeno(1,2,3-cd)pyrene	$2.74E-06$	= (8.14E+01 \times 7.30E-01 \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Naphthalene	NA	= (1.32E+03 \times NV \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Pyrene	NA	= (4.42E+02 \times NV \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
VOCs											
1,2,4-Trimethylbenzene	NA	= (2.04E+00 \times NV \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
1,3,5-Trimethylbenzene	NA	= (8.85E-01 \times NV \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									
Benzene	$4.52E-09$	= (1.78E+00 \times 5.50E-02 \times 1E-06 \times 250 \times 1 \times 330 \times 1) \div (70 \times 25,550)									

Notes:

Ing - Risk – Ingestion risk
 Csoil – Concentration in soil
 SFo – Oral Slope Factor
 CF – Unit Conversion Factor
 EF – Exposure Frequency
 ED – Exposure Duration
 VOC – Volatile organic compound

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.
 Toxicity criteria for lead have not been derived by USEPA.

SIR – Soil Ingestion Rate
 FI – Fraction Ingested from Contaminated Source
 BW – Body Weight
 ATc – Averaging Time for Carcinogens
 NV – No toxicity value available for this pathway.
 NA – Not Applicable
 SVOC – Semivolatile organic compound

Attachment F

Table 7b
Risk Calculations: Reasonable Maximum Exposure
Construction Worker: Incidental Ingestion of Soil Pathway – Noncarcinogenic Effects (0-4 feet)

$$\text{Ing - HQ} = \frac{(\text{Csoil} \times \text{CF} \times \text{EF} \times \text{ED} \times \text{SIR} \times \text{FI})}{(\text{BW} \times \text{ATn} \times \text{RfDo})}$$

Equation Units	Ing - HQ unitless	= (	Csoil mg/kg	×	CF kg/mg	×	EF days/year	×	ED years	×	SIR mg/day	×	FI unitless	) ÷ (	BW kg	×	ATn days	×	RfDo ^(b) mg/kg-day)
Inorganics																				
Arsenic	4.7E-02	= (	4.40E+00	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	3.0E-04)
Lead	NA	= (	1.00E+02	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	a)
Vanadium	1.4E-02	= (	3.12E+01	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	7.0E-03)
SVOCs																				
2-Methylnaphthalene	1.5E+00	= (	1.88E+03	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	4.0E-03)
Acenaphthene	1.8E-03	= (	3.38E+02	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	6.0E-01)
Acenaphthylene	NA	= (	5.50E+02	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	NV)
Benz(a)anthracene	NA	= (	2.00E+02	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	NV)
Benz(a)pyrene	NA	= (	1.47E+02	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	NV)
Benz(b)fluoranthene	NA	= (	9.15E+01	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	NV)
Benz(k)fluoranthene	NA	= (	1.12E+02	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	NV)
Chrysene	NA	= (	1.75E+02	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	NV)
Dibenz(a,h)anthracene	NA	= (	2.14E+01	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	NV)
Dibenzofuran	1.8E-01	= (	1.11E+02	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	2.0E-03)
Fluoranthene	2.6E-03	= (	3.18E+02	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	4.0E-01)
Fluorene	2.5E-03	= (	3.06E+02	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	4.0E-01)
Indeno(1,2,3-cd)pyrene	NA	= (	8.14E+01	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	NV)
Naphthalene	2.1E-01	= (	1.32E+03	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	2.0E-02)
Pyrene	4.8E-03	= (	4.42E+02	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	3.0E-01)
VOCs																				
1,2,4-Trimethylbenzene	1.3E-04	= (	2.04E+00	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	5.0E-02)
1,3,5-Trimethylbenzene	5.7E-06	= (	8.85E-01	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	5.0E-01)
Benzene	1.4E-03	= (	1.78E+00	×	1E-06	×	250	×	1	×	330	×	1	) ÷ (	70	×	365	×	4.0E-03)

Notes:

- Ing - HQ – Ingestion Hazard
- Csoil – Concentration in Soil
- CF – Unit Conversion Factor
- EF – Exposure Frequency
- ED – Exposure Duration
- SIR – Soil Ingestion Rate
- VOC – Volatile organic compound
- FI – Fraction Ingested from Contaminated Source
- BW – Body Weight
- ATn – Averaging Time for Noncarcinogens
- RfDo – Oral reference dose
- NV – No toxicity value available for this pathway.
- NA – Not Applicable
- SVOC – Semivolatile organic compound
- a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.
Toxicity criteria for lead have not been derived by USEPA.
- b – Subchronic toxicity values were used for each individual chemical, chronic toxicity values were used if subchronic values were not available.
Toxicity criteria is presented in Attachment A, Table 1b.

Attachment F

Table 8a
Risk Calculations: Reasonable Maximum Exposure
Construction Worker: Incidental Dermal Contact with Soil Pathway – Carcinogenic Effects (0-4 feet)

$$\text{Derm - Risk} = \frac{(\text{Csoil} \times \text{SFabs} \times \text{CF} \times \text{EF} \times \text{ED} \times \text{EV} \times \text{SA} \times \text{SSAF} \times \text{ABSD})}{(\text{BW} \times \text{ATc})}$$

Equation Units	Derm - Risk	= (	Csoil	\times	SFabs	\times	CF	\times	EF	\times	ED	\times	EV	\times	SA	\times	SSAF	\times	ABSD	) \div (	BW	\times	ATc)
	unless		mg/kg		kg-day/mg		kg/mg		days/year		years		events/day		cm ²		mg/cm ² -event		unitless		kg		days	
Inorganics																								
Arsenic	1.69E-08	= (	4.40E+00	\times	1.58E+00	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	3.00E-02	) \div (	70	\times	25,550)
Lead	NA	= (	1.00E+02	\times	a	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	NA	) \div (	70	\times	25,550)
Vanadium	NA	= (	3.12E+01	\times	NV	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	NA	) \div (	70	\times	25,550)
SVOCs																								
2-Methylnaphthalene	NA	= (	1.88E+03	\times	NV	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.00E-01	) \div (	70	\times	25,550)
Acenaphthene	NA	= (	3.38E+02	\times	NV	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
Acenaphthylene	NA	= (	5.50E+02	\times	NV	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
Benz(a)anthracene	1.54E-06	= (	2.00E+02	\times	7.30E-01	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
Benz(a)pyrene	1.13E-05	= (	1.47E+02	\times	7.30E+00	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
Benz(b)fluoranthene	7.03E-07	= (	9.15E+01	\times	7.30E-01	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
Benz(k)fluoranthene	8.60E-08	= (	1.12E+02	\times	7.30E-02	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
Chrysene	1.35E-08	= (	1.75E+02	\times	7.30E-03	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
Dibenz(a,h)anthracene	1.65E-06	= (	2.14E+01	\times	7.30E+00	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
Dibenzofuran	NA	= (	1.11E+02	\times	NV	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
Fluoranthene	NA	= (	3.18E+02	\times	NV	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
Fluorene	NA	= (	3.06E+02	\times	NV	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
Indeno(1,2,3-cd)pyrene	6.25E-07	= (	8.14E+01	\times	7.30E-01	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
Naphthalene	NA	= (	1.32E+03	\times	NV	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
Pyrene	NA	= (	4.42E+02	\times	NV	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	1.30E-01	) \div (	70	\times	25,550)
VOCs																								
1,2,4-Trimethylbenzene	NA	= (	2.04E+00	\times	NV	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	NA	) \div (	70	\times	25,550)
1,3,5-Trimethylbenzene	NA	= (	8.85E-01	\times	NV	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	NA	) \div (	70	\times	25,550)
Benzene	NA	= (	1.78E+00	\times	5.50E-02	\times	1E-06	\times	250	\times	1	\times	1	\times	1,930	\times	0.3	\times	NA	) \div (	70	\times	25,550)

Notes:

- Derm - Risk – Dermal Risk
- Csoil – Concentration in Soil
- SFabs – Absorbed slope factor (SFo \div ABSgi)
- CF – Conversion factor
- EF – Exposure Frequency
- ED – Exposure Duration
- EV – Event Frequency
- VOC – Volatile organic compound
- a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.
- Toxicity criteria for lead have not been derived by USEPA.

Attachment F

Table 8b
Risk Calculations: Reasonable Maximum Exposure
Construction Worker: Incidental Dermal Contact with Soil Pathway – Noncarcinogenic Effects (0-4 feet)

$$\text{Derm - HQ} = \frac{(\text{Csoil} \times \text{CF} \times \text{EF} \times \text{ED} \times \text{EV} \times \text{SA} \times \text{SSAF} \times \text{ABSd})}{(\text{BW} \times \text{ATn} \times \text{RfDabs})}$$

Equation Units	Derm - HQ unless	= (	Csoil mg/kg	CF kg/mg	× EF days/year	× ED years	× EV events/day	×	SA cm ²	×	SSAF mg/cm ² -event	×	ABSd unitless	) ÷ (	BW kg	×	ATn days	×	RfDabs ^(b) mg/kg-day				
Inorganics																							
Arsenic	2.63E-03	= (	4.40E+00	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	3.00E-02	) ÷ (	70	×	365	×	2.85E-04
Lead	NA	= (	1.00E+02	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	NA	) ÷ (	70	×	365	×	a
Vanadium	NA	= (	3.12E+01	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	NA	) ÷ (	70	×	365	×	1.82E-04
SVOCs																							
2-Methylnaphthalene	2.66E-01	= (	1.88E+03	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	1.00E-01	) ÷ (	70	×	365	×	4.00E-03
Acenaphthene	4.15E-04	= (	3.38E+02	×	1E-06	×	250	×	1	×	1	×	1,930	×	0	×	1.30E-01	) ÷ (	70	×	365	×	6.00E-01
Acenaphthylene	NA	= (	5.50E+02	×	1E-06	×	250	×	1	×	1	×	1,930	×	0	×	1.30E-01	) ÷ (	70	×	365	×	NV
Benz(a)anthracene	NA	= (	2.00E+02	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	1.30E-01	) ÷ (	70	×	365	×	NV
Benz(a)pyrene	NA	= (	1.47E+02	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	1.30E-01	) ÷ (	70	×	365	×	NV
Benz(b)fluoranthene	NA	= (	9.15E+01	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	1.30E-01	) ÷ (	70	×	365	×	NV
Benz(k)fluoranthene	NA	= (	1.12E+02	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	1.30E-01	) ÷ (	70	×	365	×	NV
Chrysene	NA	= (	1.75E+02	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	1.30E-01	) ÷ (	70	×	365	×	NV
Dibenz(a,h)anthracene	NA	= (	2.14E+01	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	1.30E-01	) ÷ (	70	×	365	×	NV
Dibenzofuran	4.09E-02	= (	1.11E+02	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	1.30E-01	) ÷ (	70	×	365	×	2.00E-03
Fluoranthene	5.85E-04	= (	3.18E+02	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	1.30E-01	) ÷ (	70	×	365	×	4.00E-01
Fluorene	5.64E-04	= (	3.06E+02	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	1.30E-01	) ÷ (	70	×	365	×	4.00E-01
Indeno(1,2,3-cd)pyrene	NA	= (	8.14E+01	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	1.30E-01	) ÷ (	70	×	365	×	NV
Naphthalene	4.88E-02	= (	1.32E+03	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	1.30E-01	) ÷ (	70	×	365	×	2.00E-02
Pyrene	1.09E-03	= (	4.42E+02	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	1.30E-01	) ÷ (	70	×	365	×	3.00E-01
VOCs																							
1,2,4-Trimethylbenzene	NA	= (	2.04E+00	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	NA	) ÷ (	70	×	365	×	5.00E-02
1,3,5-Trimethylbenzene	NA	= (	8.85E-01	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	NA	) ÷ (	70	×	365	×	5.00E-01
Benzene	NA	= (	1.78E+00	×	1E-06	×	250	×	1	×	1	×	1,930	×	0.3	×	NA	) ÷ (	70	×	365	×	4.00E-03

Notes:

Derm - HQ – Dermal Hazard Quotient

Csoil – Concentration in Soil

ABSd – Dermal Soil Absorption Factor

CF – Unit Conversion Factor

BW – Body Weight

EF – Exposure Frequency

ATn – Averaging Time for noncarcinogens

ED – Exposure Duration

NA – Not Applicable

EV – Event Frequency

NV – No toxicity value available for this pathway.

SA – Skin Surface Area

VOC – Volatile organic compound

SSAF – Soil-to-skin Adherence Factor

SVOC – Semivolatile organic compound

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

b – Subchronic toxicity values were used for each individual chemical, chronic toxicity values were used if subchronic values were not available.

Toxicity criteria is presented in Attachment A, Table 1b.

Attachment F

Table 9a
Risk Calculations: Reasonable Maximum Exposure
Construction Worker: Incidental Inhalation of Soil (Fugitive Emissions and Volatile Compounds) Pathway – Carcinogenic Effects (0-4 feet)

$\text{Inh - Risk} = \frac{(\text{Csoil} \times \text{SFi} \times \text{IR} \times \text{ET} \times \text{EF} \times \text{ED} \times [(1/\text{VF}) + (1/\text{PEF})])}{(\text{BW} \times \text{ATc})}$																
Equation Units	Inh - Risk unitless	Csoil mg/kg	SFi kg-day/mg	IR m³/hour	ET hours/day	EF days/year	ED year	VF m³/kg	PEF m³/kg	BW kg	ATc days					
Inorganics																
Arsenic	8.12E-09	= (4.40E+00 × 1.51E+01 × 1.5 × 8 × 250 × 1 × [1 / NA + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Lead	NA	= (1.00E+02 × a × 1.5 × 8 × 250 × 1 × [1 / NA + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Vanadium	NA	= (3.12E+01 × NV × 1.5 × 8 × 250 × 1 × [1 / NA + 1 / 1.37E+07]) ÷ (70 × 25,550)														
SVOCs																
2-Methylnaphthalene	NA	= (1.88E+03 × NV × 1.5 × 8 × 250 × 1 × [1 / 5.68E+03 + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Acenaphthene	NA	= (3.38E+02 × NV × 1.5 × 8 × 250 × 1 × [1 / 1.10E+04 + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Acenaphthylene	NA	= (5.50E+02 × NV × 1.5 × 8 × 250 × 1 × [1 / 1.30E+04 + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Benzo(a)anthracene	NA	= (2.00E+02 × NV × 1.5 × 8 × 250 × 1 × [1 / NC + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Benzo(a)pyrene	5.56E-08	= (1.47E+02 × 3.08E+00 × 1.5 × 8 × 250 × 1 × [1 / NC + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Benzo(b)fluoranthene	NA	= (9.15E+01 × NV × 1.5 × 8 × 250 × 1 × [1 / NC + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Benzo(k)fluoranthene	NA	= (1.12E+02 × NV × 1.5 × 8 × 250 × 1 × [1 / NC + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Chrysene	NA	= (1.75E+02 × NV × 1.5 × 8 × 250 × 1 × [1 / NC + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Dibenz(a,h)anthracene	NA	= (2.14E+01 × NV × 1.5 × 8 × 250 × 1 × [1 / NC + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Dibenzofuran	NA	= (1.11E+02 × NV × 1.5 × 8 × 250 × 1 × [1 / 9.09E+03 + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Fluoranthene	NA	= (3.18E+02 × NV × 1.5 × 8 × 250 × 1 × [1 / NC + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Fluorene	NA	= (3.06E+02 × NV × 1.5 × 8 × 250 × 1 × [1 / 1.67E+04 + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Indeno(1,2,3-cd)pyrene	NA	= (8.14E+01 × NV × 1.5 × 8 × 250 × 1 × [1 / NC + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Naphthalene	NA	= (1.32E+03 × NV × 1.5 × 8 × 250 × 1 × [1 / 5.25E+03 + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Pyrene	NA	= (4.42E+02 × NV × 1.5 × 8 × 250 × 1 × [1 / 5.57E+04 + 1 / 1.37E+07]) ÷ (70 × 25,550)														
VOCs																
1,2,4-Trimethylbenzene	NA	= (2.04E+00 × NV × 1.5 × 8 × 250 × 1 × [1 / 9.98E+02 + 1 / 1.37E+07]) ÷ (70 × 25,550)														
1,3,5-Trimethylbenzene	NA	= (8.85E-01 × NV × 1.5 × 8 × 250 × 1 × [1 / 8.26E+02 + 1 / 1.37E+07]) ÷ (70 × 25,550)														
Benzene	1.40E-07	= (1.78E+00 × 2.73E-02 × 1.5 × 8 × 250 × 1 × [1 / 5.83E+02 + 1 / 1.37E+07]) ÷ (70 × 25,550)														

Notes:

Inh - Risk – Inhalation Risk

Csoil – Concentration in Soil

SFi – Inhalation Slope Factor

IR – Inhalation Rate

ET – Exposure Time

EF – Exposure frequency

ED – Exposure duration

VOC – Volatile organic compound

a – Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

VF – Volatilization Factor

PEF – Particulate Emission Factor (See Attachment G)

BW – Body Weight

ATC – Averaging Time for Carcinogens

NV – No toxicity value available for this pathway.

NA – Not Applicable

NC – Not Calculated

SVOC – Semivolatile organic compound

Attachment F

Table 9b
Risk Calculations: Reasonable Maximum Exposure
Construction Worker: Incidental Inhalation of Soil (Fugitive Emissions and Volatile Compounds) Pathway – Carcinogenic Effects

$$\text{Inh - HQ} = \frac{(\text{Csoil} \times \text{IR} \times \text{ET} \times \text{EF} \times \text{ED} \times ([1/\text{VF}] + [1/\text{PEF}]))}{(\text{BW} \times \text{ATn} \times \text{RfDI})}$$

Equation Units	Inh - HQ	=	(	Csoil	×	IR	×	ET	×	EF	×	ED	×	[1 / year]	VF	+ 1 / m³/kg	PEF	) ÷ (	BW	×	ATn	×	RfDI ^(b))
	unitless			mg/kg	m³/hour			hours/day		days/year					m³/kg	m³/kg		kg	days		mg/kg-day			
Inorganics																								
Arsenic	NA	=	(	4.40E+00	×	1.5	×	8	×	250	×	1	×	[1 /]	NA	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Lead	NA	=	(	1.00E+02	×	1.5	×	8	×	250	×	1	×	[1 /]	NA	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	a)
Vanadium	NA	=	(	3.12E+01	×	1.5	×	8	×	250	×	1	×	[1 /]	NA	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
SVOCs																								
2-Methylnaphthalene	NA	=	(	1.88E+03	×	1.5	×	8	×	250	×	1	×	[1 /]	5.68E+03	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Acenaphthene	NA	=	(	3.38E+02	×	1.5	×	8	×	250	×	1	×	[1 /]	1.10E+04	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Acenaphthylene	NA	=	(	5.50E+02	×	1.5	×	8	×	250	×	1	×	[1 /]	1.30E+04	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Benz(a)anthracene	NA	=	(	2.00E+02	×	1.5	×	8	×	250	×	1	×	[1 /]	NC	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Benz(a)pyrene	NA	=	(	1.47E+02	×	1.5	×	8	×	250	×	1	×	[1 /]	NC	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Benz(b)fluoranthene	NA	=	(	9.15E+01	×	1.5	×	8	×	250	×	1	×	[1 /]	NC	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Benz(k)fluoranthene	NA	=	(	1.12E+02	×	1.5	×	8	×	250	×	1	×	[1 /]	NC	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Chrysene	NA	=	(	1.75E+02	×	1.5	×	8	×	250	×	1	×	[1 /]	NC	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Dibenzo(a,h)anthracene	NA	=	(	2.14E+01	×	1.5	×	8	×	250	×	1	×	[1 /]	NC	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Dibenzoofuran	NA	=	(	1.11E+02	×	1.5	×	8	×	250	×	1	×	[1 /]	9.09E+03	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Fluoranthene	NA	=	(	3.18E+02	×	1.5	×	8	×	250	×	1	×	[1 /]	NC	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Fluorene	NA	=	(	3.06E+02	×	1.5	×	8	×	250	×	1	×	[1 /]	1.67E+04	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Indeno(1,2,3-cd)pyrene	NA	=	(	8.14E+01	×	1.5	×	8	×	250	×	1	×	[1 /]	NC	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
Naphthalene	3.46E+01	=	(	1.32E+03	×	1.5	×	8	×	250	×	1	×	[1 /]	5.25E+03	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	8.57E-04)
Pyrene	NA	=	(	4.42E+02	×	1.5	×	8	×	250	×	1	×	[1 /]	5.57E+04	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	NV)
VOCs																								
1,2,4-Trimethylbenzene	1.40E-01	=	(	2.04E+00	×	1.5	×	8	×	250	×	1	×	[1 /]	9.98E+02	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	1.71E-03)
1,3,5-Trimethylbenzene	7.40E-03	=	(	8.85E-01	×	1.5	×	8	×	250	×	1	×	[1 /]	8.26E+02	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	1.70E-02)
Benzene	4.19E-02	=	(	1.78E+00	×	1.5	×	8	×	250	×	1	×	[1 /]	5.83E+02	+ 1 /	1.37E+07	) ÷ (	70	×	365	×	8.57E-03)

Notes:

Inh - Risk - Inhalation Hazard Quotient

Csoil - Concentration in Soil

IR - Inhalation Rate

ET - Exposure Time

EF - Exposure frequency

ED - Exposure duration

VF - Volatilization Factor

VOC - Volatile organic compound

PEF - Particulate Emission Factor (See Attachment G)

BW - Body Weight

ATn - Averaging Time for Noncarcinogens

RfDI - Inhalation Reference Dose

NV - No toxicity value available for this pathway.

NA - Not Applicable

NC - Not Calculated

SVOC - Semivolatile organic compound

a - Quantifying risk following exposure involves many uncertainties, some of which may be unique to lead.

Toxicity criteria for lead have not been derived by USEPA.

b - Subchronic toxicity values were used for each individual chemical, chronic toxicity values were used if subchronic values were not available.

Toxicity criteria is presented in Attachment A, Table 1b.

Attachment F

Table 9c
Construction Worker: Volatilization Factor Calculations

Equation:

$$VF = \frac{Q}{C_{VF}} \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} \frac{m^2}{cm^2}$$

Chemical	Q/C _{VF} (g/m ² -s)/(kg/m ³)	π	D _A (cm ² /s)	T (s)	2	ρ _b (g/cm ³)	10 ⁻⁴ (m ² /cm ²)	VF (m ³ /kg)
1-Methylnaphthalene	73.32	3.14	1.94E-05	3.15E+07	2	1.38	1.00E-04	6.00E+03
2-Methylnaphthalene	73.32	3.14	2.17E-05	3.15E+07	2	1.38	1.00E-04	5.68E+03
Acenaphthene	73.32	3.14	5.82E-06	3.15E+07	2	1.38	1.00E-04	1.10E+04
Acenaphthylene	73.32	3.14	4.15E-06	3.15E+07	2	1.38	1.00E-04	1.30E+04
Benzo(a)anthracene	73.32	3.14	NC	3.15E+07	2	1.38	1.00E-04	NC
Benzo(a)pyrene	73.32	3.14	NC	3.15E+07	2	1.38	1.00E-04	NC
Benzo(b)fluoranthene	73.32	3.14	NC	3.15E+07	2	1.38	1.00E-04	NC
Benzo(k)fluoranthene	73.32	3.14	NC	3.15E+07	2	1.38	1.00E-04	NC
Chrysene	73.32	3.14	NC	3.15E+07	2	1.38	1.00E-04	NC
Dibenz(a,h)anthracene	73.32	3.14	NC	3.15E+07	2	1.38	1.00E-04	NC
Dibenzofuran	73.32	3.14	8.46E-06	3.15E+07	2	1.38	1.00E-04	9.09E+03
Fluoranthene	73.32	3.14	NC	3.15E+07	2	1.38	1.00E-04	NC
Fluorene	73.32	3.14	2.50E-06	3.15E+07	2	1.38	1.00E-04	1.67E+04
Indeno(1,2,3-cd)pyrene	73.32	3.14	NC	3.15E+07	2	1.38	1.00E-04	NC
Naphthalene	73.32	3.14	2.54E-05	3.15E+07	2	1.38	1.00E-04	5.25E+03
Pyrene	73.32	3.14	2.25E-07	3.15E+07	2	1.38	1.00E-04	5.57E+04
1,2,4-Trichlorobenzene	73.32	3.14	1.02E-06	3.15E+07	2	1.38	1.00E-04	2.62E+04
1,2,4-Trimethylbenzene	73.32	3.14	7.01E-04	3.15E+07	2	1.38	1.00E-04	9.98E+02
1,3,5-Trimethylbenzene	73.32	3.14	1.02E-03	3.15E+07	2	1.38	1.00E-04	8.26E+02
Benzene	73.32	3.14	2.05E-03	3.15E+07	2	1.38	1.00E-04	5.83E+02
Ethylbenzene	73.32	3.14	1.27E-03	3.15E+07	2	1.38	1.00E-04	7.41E+02
sec-Butyl benzene	73.32	3.14	1.18E-03	3.15E+07	2	1.38	1.00E-04	7.70E+02
Toluene	73.32	3.14	1.75E-03	3.15E+07	2	1.38	1.00E-04	6.32E+02
Xylenes (total)	73.32	3.14	1.07E-03	3.15E+07	2	1.38	1.00E-04	8.09E+02

Notes:

Default values are as presented in Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA 2002).

VF – Volatilization Factor (m³/kg) (calculated)

Q/C_{VF} – Inverse of mean concentration at the center of 1 acre square source
(g/m²-s)/(kg/m³)(Value used is for Minneapolis, MN.)

π – pi (3.14)

D_A – Apparent Diffusivity (cm²/s)

T – Exposure interval (s)

ρ_b – Dry soil bulk density (g/cm³) (site-specific value)

NC – Not calculated

Attachment F

Table 9d
Construction Worker: Apparent Diffusivity Calculations

Equation:

$$D_A = \frac{(\theta_a^{3.33} \times D_i \times H') + (\theta_w^{3.33} \times D_w)}{\eta^2} \times \frac{1}{(\rho_b \times K_d) + \theta_w + (\theta_a \times H')}$$

Chemical Units	VOC?	θa	Di	H'	θw	Dw	η	ρb	ρs	Kd	D _A
		(Lair / Lsoil)	(cm ² /s)	unitless	(Lwater / Lsoil)	(cm ² /s)	(Lpore / Lsoil)	(g/cm ³)	(g/cm ³)	(cm ³ /g)	(cm ² /s)
1-Methylnaphthalene	Yes	3.29E-01	6.31E-02	1.64E-02	0.15	7.13E-06	4.79E-01	1.38	2.65	3.75E+01	1.948E-05
2-Methylnaphthalene	Yes	3.29E-01	4.80E-02	2.12E-02	0.15	7.84E-06	4.79E-01	1.38	2.65	1.79E+01	2.166E-05
Acenaphthene	Yes	3.29E-01	4.21E-02	7.44E-03	0.15	7.69E-06	4.79E-01	1.38	2.65	3.67E+01	5.819E-06
Acenaphthylene	Yes	3.29E-01	4.39E-02	5.11E-03	0.15	7.53E-06	4.79E-01	1.38	2.65	3.67E+01	4.148E-06
Benz(a)anthracene	No	3.29E-01	5.10E-02	4.91E-04	0.15	9.00E-06	4.79E-01	1.38	2.65	1.39E+03	NC
Benz(a)pyrene	No	3.29E-01	4.30E-02	4.63E-05	0.15	9.00E-06	4.79E-01	1.38	2.65	4.72E+03	NC
Benz(b)fluoranthene	No	3.29E-01	2.26E-02	2.69E-05	0.15	5.56E-06	4.79E-01	1.38	2.65	4.82E+03	NC
Benz(k)fluoranthene	No	3.29E-01	2.26E-02	2.39E-05	0.15	5.56E-06	4.79E-01	1.38	2.65	4.72E+03	NC
Chrysene	No	3.29E-01	2.48E-02	2.14E-04	0.15	6.21E-06	4.79E-01	1.38	2.65	1.42E+03	NC
Dibenzo(a,h)anthracene	No	3.29E-01	2.02E-02	5.03E-06	0.15	5.18E-06	4.79E-01	1.38	2.65	1.57E+04	NC
Dibenzofuran	Yes	3.29E-01	5.51E-02	8.71E-03	0.15	7.04E-06	4.79E-01	1.38	2.65	6.78E+01	8.463E-06
Fluoranthene	No	3.29E-01	3.02E-02	3.62E-04	0.15	6.35E-06	4.79E-01	1.38	2.65	4.25E+02	NC
Fluorene	Yes	3.29E-01	3.63E-02	3.93E-03	0.15	7.88E-06	4.79E-01	1.38	2.65	6.78E+01	2.499E-06
Indeno(1,2,3-cd)pyrene	No	3.29E-01	1.90E-02	1.42E-05	0.15	5.66E-06	4.79E-01	1.38	2.65	1.61E+04	NC
Naphthalene	Yes	3.29E-01	5.90E-02	1.80E-02	0.15	7.50E-06	4.79E-01	1.38	2.65	1.10E+01	2.537E-05
Pyrene	Yes	3.29E-01	2.72E-02	4.87E-04	0.15	7.24E-06	4.79E-01	1.38	2.65	4.16E+02	2.254E-07
1,2,4-Trichlorobenzene	NV	3.29E-01	3.00E-02	1.42E-03	0.15	8.23E-06	4.79E-01	1.38	2.65	1.07E+01	1.02E-06
1,2,4-Trimethylbenzene	Yes	3.29E-01	6.44E-02	2.52E-01	0.15	7.92E-06	4.79E-01	1.38	2.65	4.31E+00	7.01E-04
1,3,5-Trimethylbenzene	Yes	3.29E-01	6.02E-02	3.59E-01	0.15	8.67E-06	4.79E-01	1.38	2.65	4.22E+00	1.02E-03
Benzene	Yes	3.29E-01	8.80E-02	2.27E-01	0.15	9.80E-06	4.79E-01	1.38	2.65	9.93E-01	2.05E-03
Ethylbenzene	Yes	3.29E-01	7.50E-02	3.22E-01	0.15	7.80E-06	4.79E-01	1.38	2.65	3.11E+00	1.27E-03
sec-Butyl benzene	Yes	3.29E-01	5.76E-02	5.07E-01	0.15	6.75E-06	4.79E-01	1.38	2.65	1.25E+01	1.18E-03
Toluene	Yes	3.29E-01	8.70E-02	2.71E-01	0.15	8.60E-06	4.79E-01	1.38	2.65	1.61E+00	1.75E-03
Xylenes (total)	Yes	3.29E-01	7.14E-02	2.71E-01	0.15	9.34E-06	4.79E-01	1.38	2.65	2.66E+00	1.07E-03

Notes:

- D_A – apparent diffusivity
- θa – air-filled soil porosity
- Di – diffusivity in air
- H' – dimensionless Henry's Law constant
- θw – water-filled soil porosity
- Dw – diffusivity in water
- η – total soil porosity
- ρb – dry soil bulk density based on soil type of silty clay. Value obtained from *User'S Guide For Evaluating Subsurface Vapor Intrusion Into Buildings* (USEPA, 2003).
- ρs – soil particle density
- Kd – soil-water partition coefficient, where:
Kd = Koc × foc
- Koc – soil organic carbon partition coefficient (cm³/g)
- foc – fraction organic carbon in soil (g/g) (A default value of 0.006 g/g was used.)
- VOC? – Volatile organic compounds; If no an apparent diffusivity was not calculated.
- NV – no value available
- NC – not calculated